PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-215372
(43)Date of publication of application : 30.07.2003

(51)Int.Cl. G02B 6/122
H01L 23/12
H05K 1/02
H05K 3/46

(21)Application number : 2002-017287
(22)Date of filing : 25.01.2002

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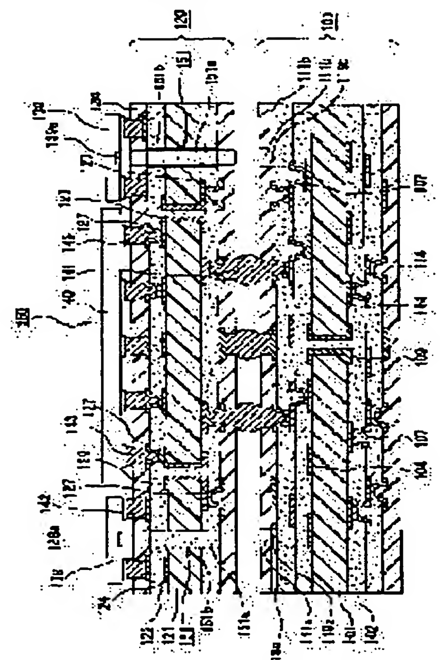
(54) DEVICE FOR OPTICAL COMMUNICATION AND MANUFACTURING METHOD THEREFOR

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a device for optical communication which enables accurate optical communication with high reliability in transmitting an optical signal, since the optical signal transmitted in an optical path for optical signal transmission is hardly attenuated or is hardly absorbed in a wall surface, when the signal is reflected by the wall of the optical path, and therefore, the loss of the optical signal hardly occurs, and is small-sized by integrating optical parts and electronic parts required for optical communication into one body.
SOLUTION: The device for optical communication comprises an IC chip mounting substrate and a multi-layered printed wiring board, and the optical path for optical signal transmission penetrating the IC chip mounting substrate is arranged in the IC chip mounting substrate, and the optical path for optical signal transmission has a glossy metallic layer formed on a part or the whole of the wall surface.



LEGAL STATUS

[Date of request for examination]	01.12.2004
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] It is the device for optical communication which the optical path for lightwave signal transmission which is the device for optical communication which consists of a substrate for IC chip mounting and a multilayer printed wiring board, and penetrates this substrate for IC chip mounting to said substrate for IC chip mounting is arranged, and is characterized by forming the metal layer which has gloss in a part or all of the wall surface, as for said optical path for lightwave signal transmission.
[Claim 2] the device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board — it is — said multilayer printed wiring board — a substrate and a conductor — the device for optical communication characterized by to be constituted including a circuit, and for the optical path for lightwave signal transmission which penetrates a substrate at least to be arranged by said multilayer printed wiring board, and to form the part or the metal layer which boils all and has gloss of the wall surface, as for said optical path for lightwave signal transmission.
[Claim 3] It is the device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board. To said substrate for IC chip mounting The optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting is arranged. Said multilayer printed wiring board a substrate and a conductor — the device for optical communication characterized by being constituted including a circuit, forming in said multilayer printed wiring board the optical path for lightwave signal transmission which penetrates a substrate at least, and forming the part or the metal layer which boils all and has gloss of the wall surface, as for said optical path for lightwave signal transmission.
[Claim 4] Said optical path for lightwave signal transmission is a device for optical communication given in any 1 of claims 1-3 constituted including the opening.
[Claim 5] Said optical path for lightwave signal transmission is a device for optical communication given in any 1 of claims 1-3 constituted including the resin constituent.
[Claim 6] Said optical path for lightwave signal transmission is a device for optical communication given in any 1 of claims 1-3 constituted including the opening and the resin constituent.
[Claim 7] The device for optical communication according to claim 5 or 6 with which the roughening side is formed in said metal layer.
[Claim 8] The resin constituent which constitutes said optical path for lightwave signal transmission is a device for optical communication given in any 1 of claims 5-7 whose transmission of communication link wavelength light is 70% or more.
[Claim 9] (a) both sides of a substrate — a conductor — with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the resin insulating layer between layers, and is used as a multilayer-interconnection plate (b) The through-hole formation process which forms a through tube in said multilayer-interconnection plate, and the metal layer formation process which forms the metal layer which has gloss on the wall surface of the (c) aforementioned through tube, (d) The substrate for IC chip mounting is manufactured using an approach including the optical element mounting process of mounting an optical element in the location which can transmit a lightwave signal through said through tube. The manufacture approach of the device for optical communication characterized by stationing both in the location which can perform transmission of a lightwave signal, and fixing to it between the optical element of said substrate for IC chip mounting, and the optical waveguide of said multilayer printed wiring board after manufacturing the multilayer printed wiring board which has optical waveguide apart from this.
[Claim 10] the substrate for IC chip mounting with which the optical element was mounted — manufacturing — this — another — both sides of the (A) substrate — a conductor — with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the resin insulating layer between layers, and is used as a multilayer-interconnection plate (B) The through-hole formation process which forms a

through tube in said multilayer-interconnection plate, and the metal layer formation process which forms the metal layer which has gloss on the wall surface of the (C) aforementioned through tube, (D) After manufacturing a multilayer printed wiring board using the approach containing the optical waveguide formation process which forms optical waveguide in the location which can transmit a lightwave signal through said through tube, The manufacture approach of the device for optical communication characterized by stationing both in the location which can perform transmission of a lightwave signal, and fixing to it between the optical element of said substrate for IC chip mounting, and the optical waveguide of said multilayer printed wiring board.
[Claim 11] (a) both sides of a substrate -- a conductor -- with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the resin insulating layer between layers, and is used as a multilayer-interconnection plate (b) The through-hole formation process which forms a through tube in said multilayer-interconnection plate, and the metal layer formation process which forms the metal layer which has gloss on the wall surface of the (c) aforementioned through tube, (d) The substrate for IC chip mounting is manufactured using an approach including the optical element mounting process of mounting an optical element in the location which can transmit a lightwave signal through said through tube. this -- another -- both sides of the (A) substrate -- a conductor -- with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the resin insulating layer between layers, and is used as a multilayer-interconnection plate (B) The through-hole formation process which forms a through tube in said multilayer-interconnection plate, and the metal layer formation process which forms the metal layer which has gloss on the wall surface of the (C) aforementioned through tube, (D) After manufacturing a multilayer printed wiring board using the approach containing the optical waveguide formation process which forms optical waveguide in the location which can transmit a lightwave signal through said through tube, The manufacture approach of the device for optical communication characterized by stationing both in the location which can perform transmission of a lightwave signal, and fixing to it between the optical element of said substrate for IC chip mounting, and the optical waveguide of said multilayer printed wiring board.
[Claim 12] The manufacture approach of the device for optical communication given in any 1 of claims 9-11 which form a closure resin layer by performing hardening processing after slushing the resin constituent for the closures between said substrates for IC chip mounting and said multilayer printed wiring boards.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of the device for optical communication, and the device for optical communication.
[0002]
[Description of the Prior Art] In recent years, attentions have gathered for the optical fiber focusing on the communication link field. In especially IT (information technology) field, the communication technology which used the optical fiber for maintenance of the high-speed Internet network is needed. In the communication system using the optical fiber which has the descriptions, such as ** low loss, ** high bandwidth, ** narrow diameter and a light weight, no ** guiding, and ** saving resources, and has these descriptions, compared with the communication system using the conventional metallic cable, the number of repeaters can be reduced substantially, construction and maintenance become easy, and an optical fiber can attain economization of communication system, and high-reliability-ization.
[0003] Moreover, since an optical fiber can multiplex simultaneously the light of the wavelength from which not only the light of one wavelength but many differ with one optical fiber, it can realize the transmission line of the large capacity which can respond to various applications, and can respond to image service etc.
[0004] Then, in network communication, such as such the Internet, using the optical communication using an optical fiber not only for the communication link of a backbone but for the communication link with a backbone and terminal equipments (a personal computer, mobile one, game, etc.) and the communication link of terminal equipments is proposed.
[0005] Thus, when using optical communication for the communication link with a backbone and a terminal equipment etc., it is necessary to attach the device for optical communication in a terminal equipment, and what was equipped with optical elements, such as optical waveguide which transmits a lightwave signal to a substrate, a photo detector which processes a lightwave signal, and a light emitting device, as a device for optical communication is proposed.
[0006]
[Problem(s) to be Solved by the Invention] However, the conventional device for optical communication was not enough satisfactory in respect of connection dependability. That is, when optical elements, such as a package substrate which mounted IC chip which constitutes the device for optical communication, a photo detector which processes a lightwave signal, and a light emitting device, etc. were mounted independently, it was difficult for equipment itself to become large and to achieve the miniaturization of a terminal equipment. Moreover, the optical element was built in, and although the problem that equipment itself became large was solved when the substrate for IC chip mounting with which IC chip was mounted was used, there was the following inconvenience.

[0007] That is, in the package substrate with a built-in optical element, it was difficult to tune alignment finely, in case it connects with external optical elements (an optical fiber, optical waveguide, etc.), since the optical element is thoroughly built in in the substrate, and since the optical element was beforehand built in in case a package substrate is manufactured, it was easy to generate a location gap of an optical element. In the production process of a package substrate, this is considered that a location gap of an optical element occurs at the time of this heat treatment, when it is necessary to perform heat treatment etc. and builds an optical element in a resin layer. Thus, when a location gap occurred in the built-in optical element, it was large and the connection loss at the time of connecting with an external optic (for example, optical waveguide) was led to lowering of the connection dependability in optical communication. Moreover, since it was not able to exchange only that optical element but that package substrate with a built-in optical element itself served as a defective when inconvenience occurs in either of the built-in optical elements in this package substrate with a built-in

optical element, it was economically disadvantageous. Moreover, the mounting position of an optical element will be restricted by reservation of the optical path for lightwave signal transmission, and the physical relationship of an optical element and the optics (optical waveguide etc.) attached in the external substrate, therefore the densification of the substrate for IC chip mounting might become difficult.
[0008] Moreover, in such a conventional terminal equipment, since the distance of the substrate for IC chip mounting and an optic was separated, electric wiring distance is long and it was easy to generate the signal error by a cross talk noise etc. at the time of a signal transmission.
[0009] in order [then,] to solve such a technical problem — this invention persons — previously — both sides of a substrate — a conductor — while laminating formation of a circuit and the resin insulating layer between layers was carried out and the solder resist layer was formed in the outermost layer of drum, the optical element is mounted and the substrate for IC chip mounting of the structure where the optical path for lightwave signal transmission which penetrates the resin insulating layer between the above-mentioned substrate and layers and a solder resist layer was arranged was invented. The above-mentioned substrate for IC chip mounting can transmit the I/O signal of an optical element through the optical path for lightwave signal transmission. Moreover, when IC chip is mounted in this substrate for IC chip mounting, while the distance of IC chip and an optical element is short and excelling in the dependability of electrical signal transmission Since electronic parts and an optical element required for optical communication were unified in the above-mentioned substrate for IC chip mounting which mounted IC chip, it was what can contribute to the miniaturization of the terminal machine for optical communication.
[0010] since the adhesion of this resin layer for optical paths and the wall surface of the optical path for lightwave signal transmission should be excelled in such a substrate for IC chip mounting when the resin layer for optical paths was formed in the interior of the optical path for lightwave signal transmission — the above-mentioned wall surface — melanism — roughening processing of - reduction processing etc. was performed and the roughening side was formed.
[0011] Since the wall surface of the optical path for lightwave signal transmission in which such a roughening side was formed was black, in case the lightwave signal which transmits the inside of the above-mentioned optical path for lightwave signal transmission reflects on the above-mentioned wall surface, it decreases, or it is absorbed by the above-mentioned wall surface, loss occurs in a lightwave signal, the dependability of transmission of a lightwave signal falls, and it may be able to stop however, might be unable to perform exact optical communication. Since the above-mentioned wall surface was in the lusterless condition, too, in case a lightwave signal reflects on the above-mentioned wall surface, it decreases, or it is absorbed by the above-mentioned wall surface, loss occurs in a lightwave signal, the dependability of transmission of a lightwave signal falls, and it may be able to stop moreover, might be unable to perform exact optical communication, even if it was the case where a roughening side was not formed in the wall surface of the above-mentioned optical path for lightwave signal transmission.
[0012] Moreover, the optical element mounted in the substrate for IC chip mounting which this invention persons invented previously, This optical waveguide of the multilayer printed wiring board with which optical waveguide was formed in the position In case the above-mentioned lightwave signal also reflects the constituted device for optical communication on the wall surface of the optical path for lightwave signal transmission through the optical path for lightwave signal transmission so that transmission of a lightwave signal may be possible, decrease, or it is absorbed by the above-mentioned wall surface. Loss occurs in the above-mentioned lightwave signal, the dependability of transmission of a lightwave signal falls, and it may be able to stop might be unable to perform exact optical communication.
[0013]
[Means for Solving the Problem] Then, this invention persons are forming the metal layer which has gloss in a part or all of a wall surface of the optical path for lightwave signal transmission, as a result of inquiring in a detail further. It was reflected without absorbing the lightwave signal equivalent to the wall surface of the optical path for lightwave signal transmission, was hard to generate loss in a lightwave signal, and excelled in the dependability of transmission of a lightwave signal, and the device for optical communication of this invention which consists that exact optical communication can be performed of a header and the following configuration was completed.
[0014] That is, the device for optical communication of the first this invention is a device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board, the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting is arranged by the above-mentioned substrate for IC chip mounting, and the above-mentioned optical path for lightwave-signal transmission is characterized by to form the metal layer which has gloss in a part or all of the wall surface.
[0015] the device for optical communication with which the device for optical communication of the second this

invention consists of a substrate for IC chip mounting, and a multilayer printed wiring board — it is — the above-mentioned multilayer printed wiring board — a substrate and a conductor — it is constituted including a circuit, the optical path for lightwave-signal transmission which penetrates a substrate at least is arranged by the above-mentioned multilayer printed wiring board, and the above-mentioned optical path for lightwave-signal transmission is characterized by to be formed the part or the metal layer which boils all and has gloss of the wall surface.
[0016] The device for optical communication of the third this invention is a device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board. To the above-mentioned substrate for IC chip mounting The optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting is arranged. The above-mentioned multilayer printed wiring board a substrate and a conductor — it is characterized by being constituted including a circuit, forming in the above-mentioned multilayer printed wiring board the optical path for lightwave signal transmission which penetrates a substrate at least, and forming the part or the metal layer which boils all and has gloss of the wall surface, as for the above-mentioned optical path for lightwave signal transmission.
[0017] As for the above-mentioned optical path for lightwave signal transmission, in the device for optical communication of the first - the third this invention, it is desirable for it to be constituted including the opening, to be constituted including the resin constituent, or to be constituted including an opening and a resin constituent.
[0018] Moreover, in the above-mentioned device for optical communication, it is desirable in the above-mentioned metal layer to form the roughening side. Moreover, as for the resin constituent which constitutes the above-mentioned optical path for lightwave signal transmission, in the above-mentioned device for optical communication, it is desirable for the permeability of communication link wavelength light to be 70% or more.
[0019] The manufacture approach of the device for optical communication of the fourth this invention (a) — both sides of a substrate — a conductor — with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the resin insulating layer between layers, and is used as a multilayer-interconnection plate (b) The through-hole formation process which forms a breakthrough in the above-mentioned multilayer-interconnection plate, and the metal layer formation process which forms the metal layer which has gloss on the wall surface of the (c) above-mentioned breakthrough, (d) The substrate for IC chip mounting is manufactured using an approach including the optical element mounting process of mounting an optical element in the location which can transmit a lightwave signal through the above-mentioned breakthrough. After manufacturing the multilayer printed wiring board which has optical waveguide apart from this, it is characterized by stationing both in the location which can perform transmission of a lightwave signal, and fixing to it between the optical element of the above-mentioned substrate for IC chip mounting, and the optical waveguide of the above-mentioned multilayer printed wiring board.
[0020] Moreover, the manufacture approach of the device for optical communication of the fifth this invention the substrate for IC chip mounting with which the optical element was mounted — manufacturing — this — another — both sides of the (A) substrate — a conductor — with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the resin insulating layer between layers, and is used as a multilayer-interconnection plate (B) The through-hole formation process which forms a breakthrough in the above-mentioned multilayer-interconnection plate, and the metal layer formation process which forms the metal layer which has gloss on the wall surface of the (C) above-mentioned breakthrough, (D) After manufacturing a multilayer printed wiring board using the approach containing the optical waveguide formation process which forms optical waveguide in the location which can transmit a lightwave signal through the above-mentioned breakthrough, It is characterized by stationing both in the location which can perform transmission of a lightwave signal, and fixing to it between the optical element of the above-mentioned substrate for IC chip mounting, and the optical waveguide of the above-mentioned multilayer printed wiring board.
[0021] Moreover, the manufacture approach of the device for optical communication of the sixth this invention (a) — both sides of a substrate — a conductor — with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the resin insulating layer between layers, and is used as a multilayer-interconnection plate (b) The through-hole formation process which forms a breakthrough in the above-mentioned multilayer-interconnection plate, and the metal layer formation process which forms the metal layer which has gloss on the wall surface of the (c) above-mentioned breakthrough, (d) The substrate for IC chip mounting is manufactured using an approach including the optical element mounting process of mounting an optical element in the location which can transmit a lightwave signal through the above-mentioned breakthrough. this — another — both sides of the (A) substrate — a conductor — with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the resin insulating layer between layers, and is used as a multilayer-interconnection plate (B) The through-hole formation process which forms a

breakthrough in the above-mentioned multilayer-interconnection plate, and the metal layer formation process which forms the metal layer which has gloss on the wall surface of the (C) above-mentioned breakthrough, (D) After manufacturing a multilayer printed wiring board using the approach containing the optical waveguide formation process which forms optical waveguide in the location which can transmit a lightwave signal through the above-mentioned breakthrough, It is characterized by stationing both in the location which can perform transmission of a lightwave signal, and fixing to it between the optical element of the above-mentioned substrate for IC chip mounting, and the optical waveguide of the above-mentioned multilayer printed wiring board.
[0022] Moreover, after slushing the resin constituent for closure between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board by the manufacture approach of the device for optical communication of the fourth - the sixth this invention, it is desirable by performing hardening processing to form a closure resin layer.
[0023]
[Embodiment of the Invention] First, the device for optical communication of the first this invention is explained. The device for optical communication of the first this invention is a device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board, the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting is arranged by the above-mentioned substrate for IC chip mounting, and the above-mentioned optical path for lightwave signal transmission is characterized by to form the metal layer which has gloss in a part or all of the wall surface.
[0024] In the device for optical communication of the first this invention, since the metal layer which has the gloss formed in a part or all of a wall surface of the optical path for lightwave signal transmission can reflect suitably the lightwave signal which transmits the inside of the above-mentioned optical path for lightwave signal transmission, the above-mentioned lightwave signal declines by hitting the wall surface of the optical path for lightwave signal transmission, or is hard to be absorbed. Therefore, since it is hard to generate loss in the lightwave signal which transmits the inside of the optical path for lightwave signal transmission according to the device for optical communication of the first this invention, the dependability of transmission of a lightwave signal is high and exact optical communication can be realized.
[0025] In the device for optical communication of the first this invention, the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting to the substrate for IC chip mounting which constitutes the device for optical communication is arranged. In the device for optical communication of this invention which comes to contain the substrate for IC chip mounting with which such an optical path for lightwave signal transmission was arranged, a lightwave signal can perform transfer of the information on the optical element mounted in the above-mentioned substrate for IC chip mounting, and the optic mounted in the multilayer printed wiring board through this optical path for lightwave signal transmission.
[0026] In the device for optical communication of the first this invention, the metal layer to which the above-mentioned optical path for lightwave signal transmission has gloss in a part or all of the wall surface is formed. Thus, since it is suitably reflected in the metal layer which has the above-mentioned gloss when the metal layer which has gloss was formed in a part or all of a wall surface of the optical path for lightwave signal transmission and the lightwave signal which transmits the interior of the above-mentioned optical path for lightwave signal transmission is equivalent to the wall surface of the optical path for lightwave signal transmission, it is hard to generate loss in a lightwave signal, and the dependability of lightwave-signal transmission can be raised. In addition, although the metal layer which has the above-mentioned gloss is formed in a part of wall surface of the optical path for lightwave signal transmission or is formed in all of the above-mentioned wall surfaces When the metal layer which has the above-mentioned gloss is formed in a part of wall surface of the optical path for lightwave signal transmission, as for the metal layer which has the above-mentioned gloss, it is desirable to be formed in the wall surface of the part which penetrates the substrate of the optical path for lightwave signal transmission and the resin insulating layer between layers. Usually, a substrate and the resin insulating layer between layers have high adhesion with a metal, and a solder resist layer is because adhesion with a metal is low.
[0027] Moreover, as for the above-mentioned optical path for lightwave signal transmission, being constituted including an opening is desirable. When the optical path for lightwave signal transmission is formed including the opening, while the formation is easy, in transmission of the lightwave signal through this optical path for lightwave signal transmission, it is hard to generate transmission loss. In addition, in consideration of the thickness of the substrate for IC chip mounting etc., it should just determine suitably whether the configuration of the above-mentioned optical path for lightwave signal transmission is made into an opening.
[0028] Moreover, as for the above-mentioned optical path for lightwave signal transmission, being constituted including a resin constituent is also desirable. When the above-mentioned optical path for lightwave signal transmission is constituted including the resin constituent, lowering of the reinforcement of the substrate for IC

chip mounting can be prevented. Moreover, if the optical path for lightwave signal transmission is constituted by the resin constituent, since it can prevent that dust, a foreign matter, etc. enter in this optical path for lightwave signal transmission, it can prevent that originate in existence of dust, a foreign matter, etc. and transmission of a lightwave signal is checked.
[0029] Moreover, as for the above-mentioned optical path for lightwave signal transmission, being constituted including a resin constituent and an opening is also desirable. When the above-mentioned optical path for lightwave signal transmission is constituted including the resin constituent and the opening, lowering of the reinforcement of the substrate for IC chip mounting can be prevented. In addition, when the above-mentioned optical path for lightwave signal transmission is constituted by the resin constituent and the opening, it is desirable for the optical path for lightwave signal transmission formed in the part which penetrates a substrate and a layer insulation layer to be constituted by the resin constituent, and for the optical path for lightwave signal transmission formed in the solder resist layer to be constituted by the opening. Usually, a substrate and a layer insulation layer have high adhesion with resin, and a solder resist layer is because adhesion with resin is low.
[0030] Hereafter, the device for optical communication of the first this invention is explained, referring to a drawing. Drawing 1 is the sectional view showing typically 1 operation gestalt of the device for optical communication of the first this invention. In addition, the device for optical communication in the condition that IC chip was mounted is shown in drawing 1 .
[0031] As shown in drawing 1 , the device 150 for optical communication of the first this invention consists of the substrates 120 for IC chip mounting and multilayer printed wiring boards 100 which mounted the IC chip 140, and the substrate 120 for IC chip mounting and the multilayer printed wiring board 100 are electrically connected through the solder connection 141.
[0032] the substrate 120 for IC chip mounting — both sides of a substrate 121 — a conductor — the conductor with which laminating formation was carried out and the substrate 121 of the layer insulation layer [a circuit 124 and] 122 was pinched — circuits and the conductor whose layer insulation layer 122 was pinched — circuits are electrically connected by the through hole 129 and the Bahia hall 127, respectively. Moreover, the optical path 151 for lightwave-signal transmission which penetrates this is formed in the substrate 120 for IC chip mounting, and this optical path 151 for lightwave-signal transmission consists of metal layer 151b which has the gloss formed in the wall surface around the part which penetrates the substrate 121 of resin layer 151a for optical paths formed in a part of that interior, and resin layer 151a for optical paths, and the resin insulating layer 122 between layers. Therefore, the optical path 151 for lightwave signal transmission consists of resin layer (resin constituent) 151for optical paths a, and an opening and metal layer 151b of these perimeters. In addition, with the device 150 for optical communication shown in drawing 1 , although the optical path 151 for lightwave signal transmission consists of resin layer (resin constituent) 151for optical paths a, and an opening and metal layer 151b of these perimeters, the optical path 151 for lightwave signal transmission may consist of an opening and a metal layer of these perimeters, and may consist of a resin layer for optical paths (resin constituent), and a metal layer of these perimeters.
[0033] Moreover, a photo detector 138 and a light emitting device 139 are mounted in the near field where the IC chip 140 was mounted, and through the optical path 151 for lightwave signal transmission, it consists of substrates 120 for IC chip mounting so that a lightwave signal can be transmitted between a photo detector 138, a light emitting device 139, and optical waveguide 119 (119a, 119b). Furthermore, the solder resist layer 134 equipped with the solder bump is formed in the outermost layer of drum of the mounting substrate 120 for IC chip.
[0034] a multilayer printed wiring board 100 — both sides of a substrate 101 — a conductor — the conductor with which laminating formation was carried out and the substrate 101 of the layer insulation layer [a circuit 104 and] 102 was pinched — circuits and the conductor whose layer insulation layer 102 was pinched — circuits are electrically connected by the through hole 109 and the Bahia hall 107, respectively. Moreover, while the solder resist layer 114 equipped with the opening 111 for optical paths and a solder bump is formed in the mounting substrate 120 for IC chip of a multilayer printed wiring board 100, and the outermost layer of drum of the side which counters, the optical waveguide 118 (118a, 118b) equipped with the optical conversion mirror 119 (119a, 119b) is formed directly under [for optical paths] opening 111 (111a, 111b).
[0035] In the device 150 for optical communication which consists of such a configuration The lightwave signal sent from the outside through an optical fiber (not shown) is introduced into optical waveguide 118a. After being sent to the photo detector 138 (light sensing portion 138a) through optical-path conversion mirror 119a, opening 111for optical paths a, and the optical path 151 for lightwave signal transmission, it changes into an electrical signal by the photo detector 138 — having — further — the solder connection 142 and a conductor — it will be sent to the IC chip 140 through a circuit 124, the Bahia hall 127, and the solder connection 143.

[0036] Moreover, the electrical signal sent out from the IC chip 140 the solder connection 143, the Bahia hall 127, and a conductor — a circuit 124 — and After being sent to a light emitting device 139 through the solder connection 142, it is changed into a lightwave signal by the light emitting device 139. this lightwave signal — the optical path 151 for lightwave signal transmission from a light emitting device 139 (light-emitting part 139a), and opening 111for optical paths b — and it conversion mirror [optical] 119b minds, is introduced into optical waveguide 118b, and is delivery outside as a lightwave signal through an optical fiber (not shown) further — it will be carried out.
[0037] In the substrate for IC chip mounting which constitutes the device for optical communication of such first this invention In order to perform light / electrical signal conversion in the photo detector and light emitting device which were mounted in the location near the inside of the substrate for IC chip mounting, i.e., IC chip, Since an optic and electronic parts required for optical communication can be unified while the transmission distance of an electrical signal is short, is excellent in the dependability of a signal transmission and can respond to a high-speed communication link more, it can contribute to the miniaturization of the terminal equipment for optical communication. moreover, the electrical signal sent out from IC chip is delivery outside through an optical fiber, after being changed into a lightwave signal, as mentioned above — it is not only carried out, but it sends to a multilayer printed wiring board through a solder connection — having — the conductor of this multilayer printed wiring board — it will be sent to electronic parts, such as other IC chips mounted in the multilayer printed wiring board, through a circuit (the Bahia hall and a through hole are included). Moreover, with the device 150 for optical communication which consists of such a configuration, since it is hard to generate location gap in the photo detector mounted in the substrate for IC chip mounting, a light emitting device, and the optical waveguide formed in the multilayer printed wiring board, it will excel in the connection dependability of a lightwave signal.
[0038] In addition, although the formation location of the optical waveguide in the multilayer printed wiring board shown in drawing 1 is on the layer insulation layer of the outermost layer of drum of the side near the substrate for IC chip mounting, in the multilayer printed wiring board which constitutes the device for optical communication of the first this invention, the formation location of optical waveguide may not necessarily be limited here, may be between layer insulation layers, and may be on a substrate.
[0039] Moreover, in the substrate 120 for IC chip mounting shown in drawing 1 , metal layer 151b which has gloss on the wall surface of the part which penetrates the substrate 121 of the optical path 151 for lightwave signal transmission and the resin insulating layer 122 between layers is formed. Thus, by the metal layer which has gloss on the wall surface of the optical path for lightwave signal transmission being formed, a lightwave signal is suitably reflected in the above-mentioned metal layer, it is hard to generate loss of a lightwave signal, and the device for optical communication of the first this invention becomes the thing excellent in the dependability of a signal transmission, in case a lightwave signal transmits the inside of the optical path for lightwave signal transmission. Moreover, the substrate for IC chip mounting which constitutes the device for optical communication of the first this invention although metal layer 151b is formed in a part of optical path 151 for lightwave signal transmission (part which penetrates a substrate 121 and the resin insulating layer 122 between layers) in the substrate 120 for IC chip mounting shown in drawing 1 may be the structure where the metal layer was formed in all of the wall surfaces of for example, the optical path for lightwave signal transmission.
[0040] The above-mentioned metal layer is a metal layer which has gloss, and gold, silver, nickel, platinum, aluminum, a rhodium, etc. are mentioned as the construction material. It is because each of these metals has gloss and can reflect a lightwave signal suitably. Moreover, depending on the case, copper, palladium, etc. can also be used as an ingredient of the above-mentioned metal layer. However, since the oxide skin to which the glossiness of the front face of the metal layer which these ingredients oxidized, and it was [ingredients] easy and was formed is reduced is easy to be formed, it is necessary to raise the glossiness of the front face of a metal layer by removing the above-mentioned oxide skin. In addition, in the substrate for IC chip mounting which constitutes the device for optical communication of the first this invention, if it is not limited to what was mentioned above as an ingredient of a metal layer and has a specular gloss or visibility gloss, other metals can also be used.
[0041] The value acquired by measuring the spectral reflectance of a metal side can express the glossiness of the above-mentioned metal layer. Measurement of the spectral reflectance of the above-mentioned metal side forms the metal membrane which consists of construction material of the above-mentioned metal layer, and same construction material with vacuum deposition, and can be performed by measuring the reflection factor on the front face of a metal membrane at the time of projecting light with a wavelength of 0.85 micrometers on this metal membrane vertically. Moreover, as for the metal layer which has the above-mentioned gloss in the device for optical communication of the first this invention, it is desirable for the above-mentioned spectral reflectance

to be 75% or more of thing.
[0042] Moreover, in the device for optical communication of the first this invention, when the above-mentioned resin layer for optical paths is formed in the interior of the above-mentioned optical path for lightwave signal transmission, in the above-mentioned metal layer, it is desirable to form the roughening side. By forming a roughening side in the above-mentioned optical path for lightwave signal transmission, the adhesion of the optical path for lightwave signal transmission and the above-mentioned resin for optical paths can be raised more. a minimum with the average relative roughness of the roughening side formed in the above-mentioned metal layer usually desirable here — 0.1 micrometers — it is — a desirable upper limit — 5 micrometers — it is — a conductor — when the adhesion of a circuit and a layer insulation layer etc. is taken into consideration, a more desirable minimum is 0.5 micrometers and a more desirable upper limit is 3 micrometers. In addition, even if it is the case where the above-mentioned resin layer for optical paths is not formed in the interior of the above-mentioned optical path for lightwave signal transmission, it is good for the above-mentioned metal layer also as forming a roughening side.
[0043] moreover, the metal layer which has the above-mentioned gloss — much more — since — when you may become, you may consist of two or more layers more than a bilayer and the above-mentioned metal layer consists [and] more than of a bilayer, the metal layer (henceforth an innermost layer) which touches the opening which constitutes the optical path for lightwave signal transmission, and a resin constituent should just have gloss. Moreover, when the above-mentioned metal layer consists more than of a bilayer, the metal layer of an innermost layer may be formed so that a twist may also form a roughening side in an outside metal layer (a substrate and metal layer of the side near the resin insulating layer between layers) and the metal layer of the above-mentioned innermost layer may be followed at the configuration of this roughening side. While the adhesion of metal layers improves, it is because the adhesion of a metal layer and a resin constituent also improves. As for the average relative roughness of the roughening side formed in the metal layer also in this case, it is desirable that it is in the above-mentioned range. Moreover, in case a roughening side is formed in the metal layer of the above-mentioned outside, and the metal layer of an innermost layer is formed so that this roughening side may be covered, as for the metal layer of this innermost layer, it is also desirable to form so that the field which touches that coat resin layer etc. may become as flat as possible. It is because a lightwave signal reflects suitably and it is hard coming to generate loss in a lightwave signal.
[0044] Moreover, in the device for optical communication of the first this invention, when the above-mentioned optical path for lightwave signal transmission is constituted including the resin constituent, as for this resin constituent, it is desirable for the permeability of the communication link wavelength light to be 70% or more. At less than 70%, the permeability of communication link wavelength light has large loss of a lightwave signal, and is because it may lead to lowering of the transmission nature of a lightwave signal. In addition, in this description, the permeability of communication link wavelength light means the permeability of the communication link wavelength light per die length of 1mm. When the light of I1 carried out incidence to the above-mentioned resin layer for optical paths (resin constituent) in strength, passing this resin layer for optical paths 1mm, and having come out, and the intensity of light which came out is I2, it is specifically for example, the value computed by the following formula (1).
[0045]
Permeability (%) =(I2/I1) x100 ... (1)
[0046] As the above-mentioned resin layer for optical paths, especially if there is little absorption by the communication link wavelength range, it will not be limited, but as the ingredient, thermosetting resin, thermoplastics, a photopolymer, the resin with which some thermosetting resin was sensitization-ized are mentioned, for example. Specifically, the polymer manufactured from silicone resin; benz-cyclo-butene, such as polyimide resin; epoxy resin;UV hardenability epoxy resin; deuteration silicone resin, such as acrylic resin; fluorination polyimide, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, is mentioned.
[0047] Moreover, it is desirable to contain particles, such as a resin particle, an inorganic particle, and metal particles, in the above-mentioned resin layer for optical paths. By including a particle, it is because it is harder coming to generate the crack which could be made to adjust a coefficient of thermal expansion between the resin insulating layer between the optical path for lightwave signal transmission, a substrate, and layers, a solder resist layer, etc., and originated in the difference of a coefficient of thermal expansion. Moreover, fire retardancy can also be given depending on the class of particle. What consists of resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin with which some thermosetting resin was photosensitivity-ized, thermosetting resin, and thermoplastics, complex of a photopolymer and thermoplastics, etc. as the above-mentioned resin particle, for example is mentioned.
[0048] Specifically For example, an epoxy resin, phenol resin, polyimide resin, Thermosetting resin, such as a

bismaleimide resin, polyphenylene resin, polyolefin resin, and a fluororesin; The heat-curing radical of these thermosetting resin A methacrylic acid, an acrylic acid, etc. are made to react to (for example, the epoxy group in an epoxy resin). Resin which gave the acrylic radical; Phenoxy resin, polyether sulfone (PES), Thermoplastics, such as polysulfone (PSF), a polyphenylene sulfone (PPS), polyphenylene sulfide (PPES), a polyphenyl ether (PPE), and polyether imide (PI); what consists of photopolymers, such as acrylic resin, etc. is mentioned. Moreover, what consists of resin complex of the resin complex of the above-mentioned thermosetting resin and the above-mentioned thermoplastics, the resin which gave the above-mentioned acrylic radical, the above-mentioned photopolymer, and the above-mentioned thermoplastics can also be used. Moreover, the resin particle which consists of rubber can also be used as the above-mentioned resin particle.
[0049] Moreover, as the above-mentioned inorganic particle, what consists of titanium compounds, such as silicon compounds, such as magnesium compounds, such as potassium compounds, such as lime compounds, such as aluminium compounds, such as an alumina and an aluminum hydroxide, a calcium carbonate, and a calcium hydroxide, and potassium carbonate, a magnesia, a dolomite, and basic magnesium carbonate, a silica, and a zeolite, and a titania, etc. is mentioned, for example. Moreover, what was made to mix and carry out melting of a silica and the titania at a fixed rate, and was equalized may be used. Moreover, what consists of Lynn or phosphorus compounds can also be used as the above-mentioned inorganic particle.
[0050] As the above-mentioned metal particles, what consists of gold, silver, copper, palladium, nickel, platinum, iron, zinc, lead, aluminum, magnesium, calcium, etc. is mentioned, for example. These resin particles, an inorganic particle, and metal particles may be used independently, and may be used together two or more sorts.
[0051] Moreover, especially the configuration of the above-mentioned particle is not limited, for example, the shape of a globular shape, an ellipse globular shape, the letter of crushing, and a polyhedron etc. is mentioned. In these, the shape of a globular shape or an ellipse ball is desirable. It is because there is no angle in the particle of the shape of the shape of a ball, or an ellipse ball, so it is harder to generate a crack etc. in the resin layer for optical paths.
[0052] Moreover, as for the particle size of the above-mentioned particle, it is desirable that it is shorter than communication link wavelength. It is because transmission of a lightwave signal may be checked when particle size is longer than communication link wavelength. Moreover, as long as it is the particle which has the particle size of this range, the particle of two or more kinds of different particle size may be included. In addition, in this description, the particle size of a particle means the die length of the longest part of a particle.
[0053] The minimum with the desirable loadings of the particle contained in the above-mentioned resin layer for optical paths is 10 % of the weight, and a more desirable minimum is 20 % of the weight. On the other hand, the upper limit with the desirable loadings of the above-mentioned particle is 80 % of the weight, and a more desirable upper limit is 70 % of the weight. It is because transmission of a lightwave signal may be checked when the effectiveness with which a particle will be combined if the loadings of a particle are less than 10 % of the weight may not be acquired and the loadings of a particle exceed 80 % of the weight.
[0054] Moreover, especially the configuration of the above-mentioned optical path for lightwave signal transmission is not limited, for example, the shape of the shape of cylindrical and an elliptic cylinder and the square pole, many prismatic forms, etc. are mentioned. In these, the shape of a cylinder is desirable. It is because the formation is easy.
[0055] Moreover, the desirable minimum of the path of the cross section of the above-mentioned optical path for lightwave signal transmission is 100 micrometers. While there is a possibility that an optical path may be closed for the path of the above-mentioned cross section by less than 100 micrometers, it is because it may become difficult to form the resin layer for optical paths in the interior of this optical path for lightwave signal transmission. On the other hand, the desirable upper limit of the path of the above-mentioned cross section is 500 micrometers. the conductor which whose transmission nature of a lightwave signal seldom improves even if it makes it larger than 500 micrometers, but is formed in the substrate for IC chip mounting — it is because it may become the cause which checks the degree of freedom of a design of a circuit. While the path of the above-mentioned cross section is more excellent in the transmission nature of a lightwave signal, and the degree of freedom of a design, also in case it is filled up with a non-hardened resin constituent, from the point that inconvenience does not occur, the more desirable minimum is 250 micrometers and a more desirable upper limit is 350 micrometers. In addition, in the case of the shape of the diameter of the cross section, and an elliptic cylinder, in the case of the shape of the shape of the major axis of the cross section, and the square pole, or a multiple column, the path of the cross section of the above-mentioned optical path for lightwave signal transmission means the die length of the longest part of the cross section, when the above-mentioned optical path for lightwave signal transmission is a cylinder-like.
[0056] Moreover, the path of the cross section of the part which penetrates the solder resist layer of the above-mentioned optical path for lightwave signal transmission may be smaller than the path of the cross

section of the part which penetrates the resin insulating layer between a substrate and layers, and, specifically, the path of the cross section of the part which penetrates the above-mentioned solder resist layer may be smaller than the path of the cross section of the part which penetrates the resin insulating layer between the above-mentioned substrate and layers 20-150 micrometers. in addition, the conductor with which the metal layer which has the gloss formed in the wall surface of the above-mentioned optical path for lightwave signal transmission sandwiched the duty as a through hole, i.e., a substrate, depending on the case — the conductor which sandwiched between circuits, and a substrate and the resin insulating layer between layers — the duty which connects between circuits electrically can be achieved.
[0057] Moreover, it is desirable to mount optical elements, such as a photo detector and a light emitting device, in the substrate for IC chip mounting which constitutes the device for optical communication of the first this invention. As the above-mentioned photo detector, PD (photodiode), APD (avalanche photodiode), etc. are mentioned, for example. What is necessary is just to use these properly suitably in consideration of the configuration of the above-mentioned substrate for IC chip mounting, demand characteristics, etc. Si, germanium, InGaAs, etc. are mentioned as an ingredient of the above-mentioned photo detector. In these, a point to InGaAs which is excellent in light-receiving sensibility is desirable.
[0058] As the above-mentioned light emitting device, LD (semiconductor laser), DFB-LD (distribution feedback mold-semiconductor laser), LED (light emitting diode), etc. are mentioned, for example. What is necessary is just to use these properly suitably in consideration of a configuration, demand characteristics, etc. of the above-mentioned substrate for IC chip mounting.
[0059] As an ingredient of the above-mentioned light emitting device, a gallium, arsenic and the compound (GaAsP) of Lynn, a gallium, aluminum and the compound (GaAlAs) of arsenic, a gallium and the compound (GaAs) of arsenic, an indium, a gallium and the compound (InGaAs) of arsenic, an indium, a gallium, arsenic, the compound (InGaAsP) of Lynn, etc. are mentioned. That what is necessary is just to use these properly in consideration of communication link wavelength, when communication link wavelength is 0.85-micrometer band, GaAlAs can be used, and in the case of 1.3-micrometer band or 1.55-micrometer band, communication link wavelength can use InGaAs and InGaAsP.
[0060] To the multilayer printed wiring board which constitutes the device for optical communication of the first this invention, it is desirable to form optical waveguide. The inorganic system optical waveguide which consists of the organic system optical waveguide and quartz glass which consist of a polymer ingredient etc., a compound semiconductor, etc. as the above-mentioned optical waveguide, for example is mentioned. In these, the organic system optical waveguide which consists of a polymer ingredient etc. is desirable. It is because it excels in adhesion with the resin insulating layer between layers and processing is easy.
[0061] The complex of the resin and thermosetting resin with which it was not limited as the above-mentioned polymer ingredient especially when there was little absorption by the communication link wavelength range, for example, some of thermosetting resin, thermoplastics, photopolymers, and thermosetting resin were photosensitivity-ized, and thermoplastics, the complex of a photopolymer and thermoplastics, etc. are mentioned.
[0062] Specifically, silicone resin, such as polyimide resin, such as acrylic resin, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, and fluorination polyimide, an epoxy resin, UV hardenability epoxy resin, polyolefine system resin, and deuteration silicone resin, the polymer manufactured from benz-cyclo-butene are mentioned.
[0063] Particles, such as for example, a resin particle, an inorganic particle, and metal particles, may be contained in the above-mentioned optical waveguide in addition to the above-mentioned resinous principle. The thing same as an example of the above-mentioned particle as the particle contained in the above-mentioned closure resin layer etc. is mentioned.
[0064] Moreover, especially the configuration of the above-mentioned particle is not limited, for example, the shape of a globular shape, an ellipse globular shape, the letter of crushing, and a polyhedron etc. is mentioned. In these, the shape of a globular shape or an ellipse ball is desirable. It is because there is no angle in the particle of the shape of the shape of a ball, or an ellipse ball, so it is harder to generate a crack etc. in optical waveguide.

[0065] Moreover, as for the particle size of the above-mentioned particle, it is desirable that it is shorter than communication link wavelength. It is because transmission of a lightwave signal may be checked when particle size is longer than communication link wavelength. Moreover, as long as it is the particle which has the particle size of this range, the particle of two or more kinds of different particle size may be contained.
[0066] The minimum with the desirable loadings of the particle contained in the above-mentioned optical waveguide is 10 % of the weight, and a more desirable minimum is 20 % of the weight. On the other hand, the upper limit with the desirable loadings of the above-mentioned particle is 80 % of the weight, and a more

desirable upper limit is 70 % of the weight. When the effectiveness with which a particle will be combined if the loadings of a particle are less than 10 % of the weight may not be acquired and the loadings of a particle exceed 80 % of the weight, although especially the configuration of the above-mentioned optical waveguide is not limited, since [which is because transmission of a lightwave signal may be checked] the formation is easy, the shape of a sheet is desirable again.

[0067] Thus, when a particle is contained in optical waveguide, adjustment of a coefficient of thermal expansion can be aimed at between optical waveguide, the substrate which constitutes a multilayer printed wiring board, the resin insulating layer between layers, etc., and it is harder coming to generate a crack, exfoliation, etc. resulting from the difference of a coefficient of thermal expansion.

[0068] Moreover, the thickness of the above-mentioned optical waveguide has desirable 1-100 micrometers, and the width of face has desirable 1-100 micrometers. the conductor which constitutes a multilayer printed wiring board if the above-mentioned width of face is not sometimes easy for the formation in less than 1 micrometer and the above-mentioned width of face exceeds 100 micrometers on the other hand -- it may become the cause which checks the degree of freedom of designs, such as a circuit

[0069] Moreover, the ratio of the thickness of the above-mentioned optical waveguide and width of face has a desirable way near 1:1. It is because the loss at the time of transmitting a lightwave signal becomes larger as the ratio of the above-mentioned thickness and width of face shifts from 1:1. Furthermore, when the above-mentioned optical waveguide is the optical waveguide of the single mode which is the communication link wavelength of 1.55 micrometers, as for the thickness and width of face, it is desirable that it is 5-15 micrometers, and when the above-mentioned optical waveguide is the optical waveguide of a multimode on the communication link wavelength of 0.85 micrometers, it is desirable [the thickness and width of face] that it is 20-80 micrometers.

[0070] Moreover, as the above-mentioned optical waveguide, it is desirable to form the optical waveguide for light-receiving and the optical waveguide for luminescence. In addition, the above-mentioned optical waveguide for light-receiving means the optical waveguide for transmitting the lightwave signal sent from the outside through an optical fiber etc. to a photo detector, and the above-mentioned optical waveguide for luminescence means the optical waveguide for transmitting the lightwave signal sent from the light emitting device to an optical fiber etc. Moreover, it is desirable for the above-mentioned optical waveguide for light-receiving and the above-mentioned optical waveguide for luminescence to be what consists of the same ingredient. It is because adjustment of a coefficient of thermal expansion etc. is easy for a scale or the formation to like.

[0071] It is desirable to form the optical-path conversion mirror in the above-mentioned optical waveguide, as mentioned above. By forming an optical-path conversion mirror, it is because it is possible to change an optical path into a desired include angle. Formation of the above-mentioned optical-path conversion mirror can be performed by cutting the end of optical waveguide so that it may mention later.

[0072] Moreover, in the multilayer printed wiring board shown in drawing 1 , although optical waveguide is formed and the solder resist layer is further formed in the outermost layer of drum, that what is necessary is just to form if needed, this solder resist layer may not form a solder resist layer, but may form the optical waveguide which consists of a lower clad, a core, and an up clad the whole surface on the resin insulating layer between layers, and may play a role of a solder resist layer by the clad in the above-mentioned upper part. The device for optical communication of this invention which consists of such a configuration can be manufactured by the manufacture approach of the device for optical communication of this invention mentioned later.

[0073] Moreover, it will be sent to a multilayer printed wiring board 100 not only through being sent out to a multilayer printed wiring board 100 but through the solder connection 141 through the optical-path 151 grade for lightwave signal transmission as the electrical signal sent out from IC chip since the substrate 120 for IC chip mounting and the multilayer printed wiring board 100 were electrically connected through the solder connection 141 with the device 150 for the optical communication shown in drawing 1 was mentioned above, after being changed into the lightwave signal.

[0074] Thus, when the substrate for IC chip mounting and the multilayer printed wiring board are connected through the solder connection, the above-mentioned substrate for IC chip mounting can be arranged to a position according to the self-alignment operation which solder has.

[0075] In addition, it is thought that it happens in order that the surface tension which is going to become a globular form when solder is attached to a metal, while the operation which is going to exist in a stable configuration by near the center of opening for solder bump formation with the fluidity to which self has [solder] the above-mentioned self-alignment operation at the time of reflow processing is said and, as for this operation, solder is crawled by the solder resist layer may work strongly. Though location gap has occurred to both in front of a reflow in case the above-mentioned substrate for IC chip mounting is connected to a multilayer printed wiring board through the above-mentioned solder connection when this self-alignment

operation is used, the above-mentioned substrate for IC chip mounting can move at the time of a reflow, and this substrate for IC chip mounting can be attached in the exact location on a multilayer printed wiring board. Therefore, if the mounting position of the photo detector mounted in the above-mentioned substrate for IC chip mounting in the photo detector and light emitting device which were mounted in the above-mentioned substrate for IC chip mounting, and the external optic when a lightwave signal was transmitted through the optical path for lightwave signal transmission, or a light emitting device is exact, an exact lightwave signal can be transmitted between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board.

[0076] moreover, the above-mentioned device for optical communication — setting — the above-mentioned optical path for lightwave signal transmission — the micro lens may be arranged in the edge of one side at least. In addition, the above-mentioned micro lens may be directly arranged in the edge of for example, the optical path for lightwave signal transmission, and you may be arranged through the adhesives layer, and depending on the case, the above-mentioned micro lens is the interior of the optical path for lightwave signal transmission, and may be arranged into the resin layer for optical paths.

[0077] Moreover, as for the refractive index of the micro lens arranged by the end (multilayer printed wiring board side) of the above-mentioned optical path for lightwave signal transmission, it is desirable that it is larger than the refractive index of the resin layer for optical paths formed in the interior of the above-mentioned optical path for lightwave signal transmission. Since a lightwave signal can be made to condense towards desired by arranging the micro lens which has such a refractive index, transmission of a lightwave signal can be ensured.

[0078] Moreover, what is necessary is just to choose the radius of curvature of the convex of this lens suitably in consideration of the design of the optical path for lightwave signal transmission etc., when the above-mentioned micro lens is a lens of a convex configuration. It is desirable to specifically make radius of curvature small, when it is necessary to lengthen a focal distance, and when it is necessary to shorten a focal distance, it is desirable to enlarge radius of curvature.

[0079] It is not limited especially as the above-mentioned micro lens, but what is used for the optical lens is mentioned, and optical glass, the resin for optical lenses, etc. are mentioned as an example of the construction material. As the above-mentioned resin for optical lenses, the polymer manufactured from silicone resin; benz-cyclo-butene [, such as polyimide resin; epoxy resin;UV hardenability epoxy resin; polyolefine system resin; deuteration silicone resin,], such as acrylic resin; fluorination polyimide, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, is mentioned, for example.

[0080] When this micro lens may be directly arranged in the edge of the optical path for lightwave signal transmission when arranging a micro lens in the edge of the above-mentioned optical path for lightwave signal transmission, and the resin layer for optical paths is especially formed in the interior of the optical path for lightwave signal transmission (part which penetrates a solder resist layer), it is desirable to be directly arranged by this resin layer for optical paths.

[0081] Moreover, although the arrangement location of a micro lens has the desirable edge of the optical path for lightwave signal transmission of the side which counters a photo detector and a light emitting device, it is not limited here, for example, may be arranged in the edge of the optical path for lightwave signal transmission by the side of a photo detector or a light emitting device, and may be arranged in the both ends of the optical path for lightwave signal transmission. The configuration of the above-mentioned micro lens just condenses a lightwave signal besides the lens of a convex configuration towards desired.

[0082] Moreover, the operation gestalt of the device for optical communication of the first this invention may be a gestalt as not limited to the gestalt shown in drawing 1 and shown in drawing 2 . In addition, the device for optical communication in the condition that IC chip was mounted is shown in drawing 2 . As shown in drawing 2 , the device 250 for optical communication consists of the substrates 220 for IC chip mounting and multilayer printed wiring boards 200 which mounted the IC chip 240, and the substrate 220 for IC chip mounting and the multilayer printed wiring board 200 are electrically connected through the solder connection 241. Moreover, the closure resin layer 260 is formed between the substrate 220 for IC chip mounting, and the multilayer printed wiring board 200.

[0083] the substrate 220 for IC chip mounting — both sides of a substrate 221 — a conductor — the conductor with which laminating formation was carried out and the substrate 221 of the layer insulation layer [a circuit 224 and] 222 was pinched — circuits and the conductor whose layer insulation layer 222 was pinched — circuits are electrically connected by the through hole 229 and the Bahia hall 227, respectively. Moreover, the optical path 251 for lightwave-signal transmission which penetrates this is formed in the substrate 220 for IC chip mounting, and this optical path 251 for lightwave-signal transmission consists of metal layer 251b which has the gloss formed in the wall surface around the part which penetrates the substrate 221 of resin layer 251a for

optical paths formed in a part of that interior, and resin layer 251a for optical paths, and the resin insulating layer 222 between layers. Therefore, the optical path 251 for lightwave signal transmission consists of resin layer 251for optical paths a, and an opening and metal layer 251b of these perimeters.

[0084] a multilayer printed wiring board 200 — both sides of a substrate 201 — a conductor — the conductor with which laminating formation was carried out and the substrate 201 of the resin insulating layer [a circuit 204 and] 202 between layers was pinched — the conductor which sandwiched circuits and the resin insulating layer 202 between layers — circuits are electrically connected by the through hole 209 and the Bahia hall 207, respectively. moreover, in the mounting substrate 220 for IC chip of a multilayer printed wiring board 200, and the outermost layer of drum of the side which counters While the solder resist layer 214 equipped with the opening 211 for optical paths and a solder bump is formed The optical waveguide 218 (218a, 218b) equipped with the optical conversion mirror 219 (219a, 219b) is formed directly under [for optical paths] opening 211 (211a, 211b), and the resin layer 208 (208a, 208b) for optical paths is formed in the opening 211 for optical paths.

[0085] In the device 250 for optical communication which consists of such a configuration The lightwave signal sent from the outside through an optical fiber (not shown) etc. It is introduced into optical waveguide 218a. To optical-path conversion mirror 219a, opening 211for optical paths a and the closure resin layer 260, and a pan after being sent to a photo detector 238 (light sensing portion 238a) through the optical path 251 for lightwave signal transmission, it changes into an electrical signal by the photo detector 238 — having — further — a conductor — it will be sent to the IC chip 240 through a circuit and a solder connection.

[0086] Moreover, the electrical signal sent out from the IC chip 240 After being sent to a light emitting device 239 through a circuit, it is changed into a lightwave signal by the light emitting device 239. a solder connection and a conductor — And conversion mirror [optical] 219b Mind and it is introduced into optical waveguide 218b. this lightwave signal — the optical path 251 for lightwave signal transmission from a light emitting device 239 (light-emitting part 239a), the closure resin layer 260, and opening 211for optical paths b — furthermore, it is delivery outside as a lightwave signal through an optical fiber (not shown) etc. — it will be carried out.

[0087] Moreover, in the device 250 for optical communication shown in drawing 2 , the closure resin layer 260 is formed between the substrate 220 for IC chip mounting, and the multilayer printed wiring board 200. Thus, since dust, a foreign matter, etc. which are floating the inside of air do not enter between an optical element and optical waveguide and transmission of a lightwave signal is not checked by existence of dust or a foreign matter, the device for optical communication with which the closure resin layer is formed between the substrate for IC chip mounting and the multilayer printed wiring board will be more excellent in dependability.

[0088] As the above-mentioned closure resin layer, especially if there is little absorption by the communication link wavelength range, it will not be limited, but as the ingredient, the same thing as the resin layer for optical paths formed in the optical path for lightwave signal transmission in the device for optical communication of the first this invention is mentioned, for example.

[0089] Moreover, as for the above-mentioned closure resin layer, it is desirable for the permeability of communication link wavelength light to be 70% or more. At less than 70%, the transmission of communication link wavelength light has large loss of a lightwave signal, and is because it may lead to lowering of the dependability of the device for optical communication. In addition, the permeability of the above-mentioned communication link wavelength light is as having mentioned above.

[0090] Moreover, it is desirable to contain particles, such as a resin particle, an inorganic particle, and metal particles, in the above-mentioned closure resin layer. By including a particle, it is because it is harder coming to generate the crack which could be made to adjust a coefficient of thermal expansion between the above-mentioned substrate for IC chip mounting, or the above-mentioned multilayer printed wiring board, and originated in the difference of a coefficient of thermal expansion. The same thing as the particle contained in the resin layer for optical paths explained as an example of the above-mentioned particle in the substrate for IC chip mounting which constitutes the device for optical communication of the first this invention etc. is mentioned.

[0091] In the device for optical communication of the first this invention, it is desirable for the refractive index of the above-mentioned optical path for lightwave signal transmission to be smaller than the refractive index of the above-mentioned closure resin layer. In such a case, since the lightwave signal transmitted through the above-mentioned optical path for lightwave signal transmission will condense toward the light sensing portion of a photo detector, transmission of a lightwave signal can be ensured. Moreover, since it is refracted in the direction which does not spread in the interface of the optical path for lightwave signal transmission, and a closure resin layer, the lightwave signal sent out from the above-mentioned light emitting device will be more certainly transmitted toward optical waveguide through a closure resin layer.

[0092] In the above-mentioned device for optical communication, as the metal layer is formed in the wall surface and it is shown in drawing 2 , as for the optical path for lightwave signal transmission, it is desirable to form the resin layer for optical paths in the whole interior. In case a closure resin layer is formed, when the interior of the

optical path for lightwave signal transmission is constituted by the opening, a closure resin layer may enter the part within this optical path for lightwave signal transmission, and, thereby, transmission of a lightwave signal may be checked.

[0093] Moreover, it is desirable to form the resin layer for optical paths in the above-mentioned device for optical communication also in opening for optical paths prepared in the multilayer printed wiring board, and it is desirable for the refractive index of the above-mentioned resin constituent to be smaller than the refractive index of a closure resin layer in this case. In this case, it will be condensed toward the optical-path conversion mirror of the optical waveguide formed in the multilayer printed wiring board, and the lightwave signal transmitted from the substrate side for IC chip mounting can ensure transmission of a lightwave signal. Moreover, since it is refracted in the direction which does not spread in the interface of the above-mentioned opening for optical paths, and a closure resin layer, the lightwave signal sent out from optical waveguide will be more certainly transmitted toward the optical path for lightwave signal transmission through a closure resin layer.

[0094] Moreover, while the resin layer for optical paths is formed in the interior of the above-mentioned optical path for lightwave signal transmission, the resin layer for optical paths is formed also in the interior of the above-mentioned opening for optical paths, and when the thickness of the above-mentioned optical path for lightwave signal transmission and the thickness of opening for optical paths are abbreviation identitases, the refractive index of the resin layer for both optical paths is smaller than the refractive index of a closure resin layer, and it is desirable that it is abbreviation identitas. It is because transmission of a lightwave signal can be ensured between an optical element and optical waveguide. The device for optical communication of the first this invention which consists of such a configuration can be manufactured using the manufacture approach of the device for optical communication of the fourth this invention mentioned later, for example.

[0095] Next, the manufacture approach of the device for optical communication of the fourth this invention is explained. The manufacture approach of the device for optical communication of the fourth this invention (a) — both sides of a substrate — a conductor — with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the resin insulating layer between layers, and is used as a multilayer-interconnection plate (b) The through-hole formation process which forms a breakthrough in the above-mentioned multilayer-interconnection plate, and the metal layer formation process which forms the metal layer which has gloss on the wall surface of the (c) above-mentioned breakthrough, (d) The substrate for IC chip mounting is manufactured using an approach including the optical element mounting process of mounting an optical element in the location which can transmit a lightwave signal through the above-mentioned breakthrough. After manufacturing the multilayer printed wiring board which has optical waveguide apart from this, it is characterized by stationing both in the location which can perform transmission of a lightwave signal, and fixing to it between the optical element of the above-mentioned substrate for IC chip mounting, and the optical waveguide of the above-mentioned multilayer printed wiring board.

[0096] The substrate for IC chip mounting which constitutes the device for optical communication manufactured by the manufacture approach of the device for optical communication of the fourth this invention Since the metal layer which has gloss in a part or all of a wall surface of the optical path for lightwave signal transmission is formed and this metal layer can reflect suitably the lightwave signal which transmits the inside of the above-mentioned optical path for lightwave signal transmission, while an optical element is mounted in a position, It decreases because the above-mentioned lightwave signal is equivalent to the wall surface of the optical path for lightwave signal transmission, or it is hard to be absorbed, and since it is hard to generate loss of the lightwave signal which transmits the inside of the optical path for lightwave signal transmission, the dependability of transmission of a lightwave signal is high, and exact optical communication can be realized. Therefore, according to the manufacture approach of the device for optical communication of the fourth this invention, the connection loss between the mounted optics is low, and the device for optical communication which is excellent in connection dependability can be manufactured.

[0097] First, manufacture of the above-mentioned device for optical communication can manufacture independently the substrate for IC chip mounting, and a multilayer printed wiring board, and can be performed by connecting both through solder etc. after that, for example. Therefore, how to manufacture each of the substrate for IC chip mounting and a multilayer printed wiring board is explained independently first, and how to connect both is explained after that here.

[0098] Below, the manufacture approach of the substrate for IC chip mounting is explained. First, the process of the above (a), i.e., the multilayer-interconnection plate production process which manufactures a multilayer-interconnection plate, is explained in order of a process. Specifically, a multilayer-interconnection plate can be manufactured by passing through the process of following the (1) - (9).

(1) an insulating substrate — a start ingredient — carrying out — first — this insulating substrate top — a conductor — form a circuit. As the above-mentioned insulating substrate, a glass epoxy group plate, a polyester

substrate, a polyimide substrate, a bismaleimide-triazine resin (BT resin) substrate, a thermosetting polyphenylene ether substrate, copper clad laminate, a RCC substrate, etc. are mentioned, for example. Moreover, ceramic substrates, such as an alumimium nitride substrate, and a silicon substrate may be used. the above — a conductor — a circuit can be formed by performing etching processing, after forming a solid conductor layer in the front face of for example, the above-mentioned insulating substrate by nonelectrolytic plating processing etc. Moreover, you may form by performing etching processing to copper clad laminate or a RCC substrate.

[0099] moreover, the conductor whose above-mentioned insulating substrate was pinched — in making connection between circuits by the through hole, after using a drill, laser, etc. for example, for the above-mentioned insulating substrate and forming a breakthrough, the through hole is formed by performing nonelectrolytic plating processing etc. In addition, the diameter of the breakthrough for the above-mentioned through holes is usually 100-300 micrometers. Moreover, when a through hole is formed, it is desirable to be filled up with a resin filler in this through hole.

[0100] (2) next, the need — responding — a conductor — perform roughening formation processing on the surface of a circuit. as the above-mentioned roughening formation processing — melanism (oxidization) — the etching processing using the etching reagent containing - reduction processing, the second copper complex, and an organic-acid salt etc., processing by the Cu-nickel-P needlelike alloy plating, etc. are mentioned. Here, when a roughening side is formed, the minimum of the average relative roughness of this roughening side has desirable 0.1 micrometers, and 5 micrometers of an upper limit are usually desirable. a conductor — the adhesion of a circuit and the resin insulating layer between layers, and a conductor — when the effect to the electrical signal transmission ability of a circuit etc. is taken into consideration, the minimum of the above-mentioned average relative roughness has more desirable 2 micrometers, and 4 micrometers of an upper limit are more desirable. In addition, before this roughening formation processing is filled up with a resin filler in a through hole, it may be performed, and it may form a roughening side also in the wall surface of a through hole. It is because the adhesion of a through hole and a resin filler improves.

[0101] (3) next, a conductor — form the resin layer which forms the non-hardened resin layer which consists of thermosetting resin, a photopolymer, the resin with which the photosensitive radical was given to some thermosetting resin, these and thermoplastics, and included resin complex on the substrate in which the circuit was formed, or consists of thermoplastics. In addition, the resin used for a substrate, the same resin, etc. can also be used for formation of these resin layers. The resin layer which is not hardened [above-mentioned] can be formed by applying non-hardened resin by the roll coater, a curtain coating machine, etc., or carrying out thermocompression bonding of the resin film non-hardened (semi-hardening). Moreover, the resin layer which consists of the above-mentioned thermoplastics can be formed by carrying out thermocompression bonding of the resin Plastic solid fabricated in the shape of a film.

[0102] In these, the approach of carrying out thermocompression bonding of the resin film non-hardened (semi-hardening) is desirable, and sticking by pressure of a resin film can be performed for example, using a vacuum laminator etc. Moreover, although what is necessary is not to limit especially sticking-by-pressure conditions, but just to choose suitably in consideration of the presentation of a resin film etc., it is usually desirable to carry out on a pressure 0.25 - 1.0MPa, the temperature of 40-70 degrees C, the degree of vacuum of 13-1300Pa, and about [time amount 10-120 second] conditions.

[0103] As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyester resin, a bismaleimide resin, polyolefine system resin, polyphenylene ether resin, polyphenylene resin, a fluororesin, etc. are mentioned, for example. As an example of the above-mentioned epoxy resin, novolak mold epoxy resins, such as a phenol novolak mold and a cresol novolak mold, the cycloaliphatic epoxy resin which carried out dicyclopentadiene conversion are mentioned, for example.

[0104] As the above-mentioned photopolymer, acrylic resin etc. is mentioned, for example. Moreover, the thing to which the heat-curing radical, and the methacrylic acid and acrylic acid of the above-mentioned thermosetting resin were made to acrylic--ization-react as resin with which the photosensitive radical was given to some above-mentioned thermosetting resin for example, is mentioned.

[0105] As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone (PES), polysulfone (PSF), polyphenylene sulfone (PPS) polyphenylene sulfide (PPES), polyphenylene ether (PPE) polyether imide (PI), etc. are mentioned, for example.

[0106] Moreover, as the above-mentioned resin complex, especially if thermosetting resin, a photopolymer (the resin with which the photosensitive radical was given to some thermosetting resin is also included), and thermoplastics are included, it will not be limited, but as a concrete combination of thermosetting resin and thermoplastics, phenol resin / polyether sulfone, polyimide resin/polysulfone, an epoxy resin / polyether sulfone, an epoxy resin/phenoxy resin, etc. are mentioned, for example. Moreover, as a concrete combination of a

photopolymer and thermoplastics, acrylic resin/phenoxy resin, an epoxy resin / polyether sulfone etc. that acrylic-ized a part of epoxy group are mentioned, for example.

[0107] Moreover, as for the rate of a compounding ratio of thermosetting resin and the photopolymer in the above-mentioned resin complex, and thermoplastics, thermosetting resin or a photopolymer / thermoplastics =95 / 5 - 50/50 are desirable. It is because a high toughness value is securable, without spoiling thermal resistance.

[0108] Moreover, the above-mentioned resin layer may consist of resin layers from which it differs more than two-layer. It is that a lower layer is formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =50/50, and the upper layer is specifically formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =90/10 etc. While securing the outstanding adhesion with an insulating substrate by making it such a configuration, the formation ease at the time of forming opening for the Bahia halls etc. at an after process is securable.

[0109] Moreover, the above-mentioned resin layer may be formed using the resin constituent for roughening side formation. The matter of fusibility is distributed to the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer into the heat-resistant-resin matrix which is not hardened [poorly soluble] to the roughening liquid which serves as the above-mentioned resin constituent for roughening side formation from at least one sort chosen from an acid, alkali, and an oxidizer. In addition, when the same time amount immersion is carried out, the word of the above "poor solubility" and "fusibility" says relatively what has an early dissolution rate as "fusibility" to the same roughening liquid for convenience, and calls "poor solubility" relatively what has a late dissolution rate to it for convenience.

[0110] In case the above-mentioned roughening liquid is used for the resin insulating layer between layers and a roughening side is formed as the above-mentioned heat-resistant-resin matrix, what can hold the configuration of a roughening side is desirable, for example, thermosetting resin, thermoplastics, these complex, etc. are mentioned. Moreover, a photopolymer may be used. In addition, when a photopolymer is used, exposure and a development can be used for the resin insulating layer between layers, and opening for the Bahia halls can be formed.

[0111] As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyolefin resin, a fluororesin, etc. are mentioned, for example. Moreover, when sensitization-izing the above-mentioned thermosetting resin, a heat-curing radical is made to acrylic(meta)--ization-react using a methacrylic acid, an acrylic acid, etc.

[0112] As the above-mentioned epoxy resin, a cresol novolak mold epoxy resin, the bisphenol A mold epoxy resin, a bisphenol female mold epoxy resin, a phenol novolak mold epoxy resin, an alkylphenol novolak mold epoxy resin, a biphenol female mold epoxy resin, a naphthalene mold epoxy resin, a dicyclopentadiene mold epoxy resin, the epoxidation object of the condensate of phenols and the aromatic aldehyde which has a phenolic hydroxyl group, triglycidyl isocyanurate, cycloaliphatic epoxy resin, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts. Thereby, it excels in thermal resistance etc.

[0113] As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone, polysulfone, polyphenylene sulfone, polyphenylene sulfide, a polyphenyl ether, polyether imide, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts.

[0114] It is desirable that it is at least one sort as which the matter of fusibility is chosen from an inorganic particle, a resin particle, and metal particles to the roughening liquid which consists of at least one sort chosen from the above-mentioned acid, alkali, and an oxidizer.

[0115] As the above-mentioned inorganic particle, what consists of silicon compounds, such as magnesium compounds, such as potassium compounds, such as lime compounds, such as aluminium compounds, such as an alumina and an aluminum hydroxide, a calcium carbonate, and a calcium hydroxide, and potassium carbonate, a magnesia, a dolomite, basic magnesium carbonate, and talc, a silica, and a zeolite, etc. is mentioned, for example. These may be used independently and may be used together two or more sorts.

[0116] As the above-mentioned resin particle, what consists of thermosetting resin, thermoplastics, etc. is mentioned, for example. When immersed in the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer It will not be limited especially if a dissolution rate is earlier than the above-mentioned heat-resistant-resin matrix. Specifically For example, amino resin (melamine resin, a urea-resin, guanamine resin, etc.), an epoxy resin, phenol resin, phenoxy resin, polyimide resin, polyphenylene resin, polyolefin resin, a fluororesin, bismaleimide-triazine resin, etc. are mentioned. These may be used independently and may be used together two or more sorts. In addition, the above-mentioned resin particle needs to carry out hardening processing beforehand. It is because the above-mentioned resin particle will dissolve in the solvent in which a resin matrix is dissolved if it is not made to harden. Moreover, as the above-mentioned resin particle, a rubber particle, liquid phase resin, liquid phase rubber, etc. may be used.

[0117] As the above-mentioned metal particles, gold, silver, copper, tin, zinc, stainless steel, aluminum, nickel, iron, lead, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts. Moreover, the surface may be covered with resin etc. in order that the above-mentioned metal particles may secure insulation.
[0118] When two or more sorts are mixed and it uses the matter of the above-mentioned fusibility, as a combination of the matter of two sorts of fusibility to mix, the combination of a resin particle and an inorganic particle is desirable. the resin insulating layer between layers which adjustment of thermal expansion tends to plan them between poorly soluble resin, and they become from the resin constituent for roughening side formation while both of conductivity can be hurt low and can secure the insulation of the resin insulating layer between layers — a crack — not generating — the resin insulating layer between layers, and a conductor — it is because exfoliation does not occur between circuits.
[0119] It is desirable to use an organic acid in these as an acid used as the above-mentioned roughening liquid, for example, although organic acids, such as a phosphoric acid, a hydrochloric acid, a sulfuric acid, a nitric acid, and formic acid, an acetic acid, etc. are mentioned. the conductor exposed from the base of the Bahia hall when roughening processing is carried out — it is because it is hard to make a circuit corrode. As the above-mentioned oxidizer, it is desirable to, use the water solution of a chromic acid, chromate acid mixture, and alkaline permanganates (potassium permanganate etc.) etc. for example. Moreover, as the above-mentioned alkali, water solutions, such as a sodium hydroxide and a potassium hydroxide, are desirable.
[0120] The mean particle diameter of the matter of the above-mentioned fusibility has desirable 10 micrometers or less. Moreover, big coarse grain and mean particle diameter may use it combining a small particle relatively relatively [mean particle diameter / the mean particle diameter of 2 micrometers or less]. That is, it is combining the matter of the fusibility whose mean particle diameter's is 0.1-0.5 micrometers, and the matter of the fusibility whose mean particle diameter's is 1-2 micrometers etc.
[0121] Thus, when big coarse grain and mean particle diameter combine a small particle relatively relatively [particle / average], the dissolution residue of the nonelectrolytic plating film can be lost, the amount of palladium catalysts under plating resist can be lessened, and a still shallower and complicated roughening side can be formed. Furthermore, by forming a complicated roughening side, even if the irregularity of a roughening side is small, the practical Peel reinforcement is maintainable. Mean particle diameter exceeds 0.8 micrometers, and that of the above-mentioned coarse grain is less than 2.0 micrometers, and, as for a particle, it is desirable for mean particle diameter to be 0.1-0.8 micrometers.
[0122] (4) Next, in forming the resin insulating layer between layers using thermosetting resin and resin complex as the ingredient, while performing hardening processing to a non-hardened resin insulating layer, form opening for the Bahia halls and consider as the resin insulating layer between layers. Moreover, at this process, a breakthrough may be formed if needed. As for the above-mentioned opening for the Bahia halls, forming by the lasing is desirable. Moreover, when a photopolymer is used as an ingredient of the resin insulating layer between layers, you may form by the exposure development.
[0123] Moreover, in forming the resin insulating layer between layers using thermoplastics as the ingredient, opening for the Bahia halls is formed in the resin layer which consists of thermoplastics, and it considers as the resin insulating layer between layers. In this case, opening for the Bahia halls can be formed by giving the lasing. Moreover, what is necessary is just to form this breakthrough by drilling, the lasing, etc., when forming a breakthrough at this process.
[0124] As laser used for the above-mentioned lasing, carbon dioxide gas laser, ultraviolet laser, excimer laser, etc. are mentioned, for example. In these, excimer laser and the carbon dioxide gas laser of a short pulse are desirable.
[0125] Moreover, it is desirable also in excimer laser to use the excimer laser of a hologram method. A hologram method is a method which irradiates a laser beam through a hologram, a condenser lens, a laser mask, an imprint lens, etc. at the specified substance, and much openings can be once formed in a resin film layer efficiently by exposure by using this method.
[0126] Moreover, when using carbon dioxide gas laser, as for the pulse separation, it is desirable that they are 10-4 - 10 to 8 seconds. Moreover, as for the time amount which irradiates the laser for forming opening, it is desirable that it is 10 - 500 microseconds. Moreover, much openings for the Bahia halls can be formed at once by irradiating a laser beam through an optical-system lens and a mask. By minding an optical-system lens and a mask, it is the same reinforcement and is because exposure reinforcement can irradiate the same laser beam at two or more parts. Thus, after forming opening for the Bahia halls, DESUMIA processing may be performed if needed.
[0127] (5) next, the front face of the resin insulating layer between layers including the wall of opening for the Bahia halls — a conductor — form a circuit. a conductor — in forming a circuit, a thin film conductor layer is

first formed in the front face of the resin insulating layer between layers. The above-mentioned thin film conductor layer can be formed by approaches, such as nonelectrolytic plating and sputtering.
[0128] As construction material of the above-mentioned thin film conductor layer, copper, nickel, tin, zinc, cobalt, a thallium, lead, etc. are mentioned, for example. In these, what consists of the copper from a point, copper, and nickel which are excellent in an electrical property, profitability, etc. is desirable. Moreover, when the thickness of the above-mentioned thin film conductor layer forms a thin film conductor layer with nonelectrolytic plating, a desirable minimum is 0.3 micrometers, a more desirable minimum is 0.6 micrometers, a desirable upper limit is 2.0 micrometers and a more desirable upper limit is 1.2 micrometers. Moreover, when forming by sputtering, 0.1-1.0 micrometers is desirable.
[0129] Moreover, a roughening side may be formed in the front face of the resin insulating layer between layers before forming the above-mentioned thin film conductor layer. By forming a roughening side, the adhesion of the resin insulating layer between layers and a thin film conductor layer can be raised. When the resin insulating layer between layers is especially formed using the resin constituent for roughening side formation, it is desirable to form a roughening side using an acid, an oxidizer, etc.
[0130] Moreover, when a breakthrough is formed at the process of the above (4), in case a thin film conductor layer is formed on the resin insulating layer between layers, it is good also as a through hole by forming a thin film conductor layer also in the wall surface of a breakthrough.
[0131] (6) Subsequently, form plating resist on the resin insulating layer between layers by which the thin film conductor layer was formed in the front face. After the above-mentioned plating resist sticks for example, a photosensitive dry film, it can carry out adhesion arrangement of the photo mask which consists of a glass substrate with which the plating resist pattern was drawn, and can form it by performing an exposure development.
[0132] (7) After that, perform electrolysis plating by making a thin film conductor layer into a plating bar, and form an electrolysis plating layer in the above-mentioned plating-resist agenesis section. As the above-mentioned electrolysis plating, copper plating is desirable. Moreover, the thickness of the above-mentioned electrolysis plating layer has desirable 5-20 micrometers.
[0133] then, the thing for which the thin film conductor layer under the above-mentioned plating resist and this plating resist is removed — a conductor — a circuit (the Bahia hall is included) can be formed. What is necessary is just to perform clearance of the above-mentioned thin film conductor layer using etching reagents, such as mixed liquor of a sulfuric acid and a hydrogen peroxide, sodium persulfate, ammonium persulfate, a ferric chloride, and a cupric chloride, that what is necessary is just to perform clearance of the above-mentioned plating resist for example, using an alkali water solution etc. moreover, the above — a conductor — after forming a circuit, the catalyst on the resin insulating layer between layers may be removed using an acid or an oxidizer if needed. It is because lowering of an electrical property can be prevented. moreover, the method of performing etching processing, after replacing with the approach (a process (6) and (7)) of forming an electrolysis plating layer after forming this plating resist and forming an electrolysis plating layer the whole surface on a thin film conductor layer — using — a conductor — a circuit may be formed.
[0134] Moreover, when a through hole is formed in the above (4) and the process of (5), it may be filled up with a resin filler in this through hole. Moreover, when filled up with a resin filler in a through hole, a wrap lid plating layer may be formed for the surface section of a resin filler layer by performing nonelectrolytic plating if needed.
[0135] (8) Next, when a lid plating layer is formed, if needed, roughening processing can be performed on the front face of this lid plating layer, and the resin insulating layer between layers can be further formed by repeating the above (3) and the process of (4).
[0136] (9) repeating the process of above-mentioned (3) - (8) after that if needed — the both sides — a conductor — carry out laminating formation of a circuit and the resin insulating layer between layers. In addition, a through hole may be formed and it is not necessary to form at this process.
[0137] performing the process of such (1) - (9) — both sides of a substrate — a conductor — a circuit and the resin insulating layer between layers can manufacture the multilayer-interconnection plate by which laminating formation was carried out. in addition, the manufacture approach of the multilayer-interconnection plate explained in full detail here — semi ADITEBU — the manufacture approach of the multilayer-interconnection plate manufactured at the process of the above (a) although it is law — semi ADITEBU — it limits to law — not having — full ADITEBU — it can also carry out using law, a subtractive process, a package laminated layers method, the conformal method, etc. the inside of these — semi ADITEBU — law and full ADITEBU — ADITEBU of law — law is desirable. since etching precision is high — a more detailed conductor — while it is suitable for forming a circuit — a conductor — it is because the degree of freedom of a design of a circuit improves.
[0138] By the manufacture approach of the device for optical communication of the fourth this invention, after manufacturing a multilayer-interconnection plate through the process of the above (a), the process of the above

(b), i.e., the through-hole formation process which forms a breakthrough in the above-mentioned multilayer-interconnection plate, is performed. The breakthrough formed at this process will play the role of the optical path for lightwave signal transmission in the substrate for IC chip mounting. Therefore, the breakthrough formed at this process is also hereafter called breakthrough for optical paths.
[0139] Drilling, the lasing, etc. perform formation of the above-mentioned breakthrough for optical paths. The same thing as the laser used in formation of the above-mentioned opening for the Bahia halls as laser used in the above-mentioned lasing etc. is mentioned. especially the formation location of the above-mentioned breakthrough for optical paths is limited — not having — a conductor — what is necessary is just to choose suitably in consideration of the design of a circuit, IC chip, the mounting position of an optical element, etc. Moreover, as for the above-mentioned breakthrough for optical paths, it is desirable to form for every optical elements, such as a photo detector and a light emitting device. Moreover, you may form for every signal wave length. Moreover, as for the path of the cross section of the above-mentioned breakthrough for optical paths, it is desirable that it is 100-500 micrometers. the conductor which the breakthrough for optical paths may be closed, whose transmission nature of the lightwave signal of the optical path for lightwave signal transmission seldom improves even if it exceeds 500 micrometers on the other hand, but constitutes the substrate for IC chip mounting if it is less than 100 micrometers — it may become the cause which checks the degree of freedom of designs, such as a circuit
[0140] Moreover, DESUMIA processing may be performed on the wall surface of the breakthrough for optical paths after the breakthrough formation for optical paths if needed. The above-mentioned DESUMIA processing can be performed using processing for example, by the permanganic acid solution, plasma treatment, corona treatment, etc. In addition, the resin remainder in the breakthrough for optical paths, weld flash, etc. are removable by performing the above-mentioned DESUMIA processing.
[0141] Next, the process of the above (c), i.e., the metal layer formation process which forms the metal layer which has gloss on the wall surface of the above-mentioned breakthrough (breakthrough for optical paths), is performed. while forming the metal layer which has gloss on the wall surface of the breakthrough for optical paths in this metal layer formation process — the resin insulating-layer top between layers of an outermost layer of drum — a conductor — it is desirable to form a circuit. therefore — while forming in the breakthrough for optical paths the metal layer which has gloss — the resin insulating-layer top between layers of an outermost layer of drum — a conductor — how to form a circuit is explained below.
[0142] First, a conductor layer is formed in the whole front face of the resin insulating layer between layers while forming a conductor layer in the wall surface of the breakthrough for optical paths with nonelectrolytic plating etc.
[0143] Next, plating resist is formed in the whole (except for the conductor layer formed in the wall surface of the breakthrough for optical paths) front face of the above-mentioned conductor layer. What is necessary is just to perform formation of plating resist by the same approach as the process of (6) of the above (a) etc.
[0144] Next, electrolysis plating, nonelectrolytic plating, etc. are performed on the conductor layer formed in the wall surface of the above-mentioned breakthrough for optical paths, the metal layer which has gloss on the wall surface of the above-mentioned breakthrough for optical paths is formed, and plating resist is removed after that. As an ingredient of the above-mentioned metal layer, gold, silver, nickel, platinum, aluminum, a rhodium, etc. are mentioned, for example.
[0145] next, the conductor on the conductor layer again formed in the above-mentioned resin insulating-layer front face between layers — plating resist is formed in a circuit agenesis part (the end-face part of the above-mentioned breakthrough for optical paths is included). What is necessary is just to perform formation of plating resist by the approach performed at the process of (6) of the above (a), the same approach, etc.
[0146] furthermore, the conductor which became independent on the resin insulating layer between layers by performing electrolysis plating by making into a plating bar the conductor layer formed on the above-mentioned resin insulating layer between layers, forming an electrolysis plating layer in the above-mentioned plating-resist agenesis section, and removing the conductor layer under plating resist and this plating resist after that — a circuit is formed.
[0147] moreover — while forming the metal layer which has gloss on the wall surface of the above-mentioned breakthrough for optical paths — the resin insulating-layer top between layers of the outermost layer of drum of the above-mentioned multilayer-interconnection plate — the conductor of an outermost layer of drum — the following approaches may be used as an option which forms a circuit. That is, first, in case a conductor layer is formed in the wall surface of the breakthrough for optical paths with nonelectrolytic plating etc., a conductor layer is formed also in the whole front face of the resin insulating layer between layers.
[0148] next, the conductor on the conductor layer formed in this resin insulating-layer front face between layers — plating resist is formed in a circuit agenesis part. What is necessary is just to perform formation of plating

resist by the approach performed at the process of (6) of the above (a), the same approach, etc.
[0149] Furthermore, electrolysis plating is performed by making into a plating bar the wall surface of the above-mentioned breakthrough for optical paths, and the conductor layer formed on the above-mentioned resin insulating layer between layers. By forming an electrolysis plating layer in the wall surface of the above-mentioned breakthrough for optical paths, and the above-mentioned plating-resist agenesis section, and removing the conductor layer under plating resist and this plating resist after that the conductor which became independent on the resin insulating layer between layers while forming the metal layer which has gloss on the wall surface of the breakthrough for optical paths — a circuit is formed. According to this approach, the process which forms plating resist, and the process which performs electrolysis plating can be lessened. In addition, in this approach, gold, silver, nickel, platinum, or aluminum can be used as an ingredient of the electrolysis plating layer formed in a conductor layer and the breakthrough for optical paths. therefore, this case — the above — a conductor — a part of circuit will be constituted by the metal which has gloss.
[0150] moreover, the conductor formed on the metal layer which has the gloss formed in the above-mentioned breakthrough for optical paths by the manufacture approach of the device for optical communication of the fourth this invention, and the resin insulating layer between layers of an outermost layer of drum — a circuit may be formed independently. In this case, first, nonelectrolytic plating etc. is performed and a conductor layer is formed in the wall surface of the above-mentioned breakthrough for optical paths, after forming plating resist in the whole (except for the wall surface of the breakthrough for optical paths) front face of a multilayer-interconnection plate. In addition, what is necessary is just to perform formation of the above-mentioned plating resist by the same approach as the process of (6) of the above (a) etc. And nonelectrolytic plating and electrolysis plating are performed on the above-mentioned conductor layer, and the metal layer which has gloss on the wall surface of the breakthrough for optical paths is formed. As an ingredient of the metal layer which has the above-mentioned gloss, gold, silver, nickel, platinum, aluminum, a rhodium, etc. are mentioned. Then, the metal layer which has gloss through a conductor layer by exfoliating the above-mentioned plating resist on the wall surface of the breakthrough for optical paths of the above-mentioned multilayer-interconnection plate can be formed. In addition, clearance of the above-mentioned plating resist can be performed for example, using an alkali water solution etc. thus, the process of (6) of the above (a) after forming the metal layer which has gloss on the wall surface of the breakthrough for optical paths, and (7) — the same — carrying out — the front face of the resin insulating layer between layers of an outermost layer of drum — a conductor — a circuit can be formed. In addition, as an approach of forming the metal layer which has gloss, approaches, such as vacuum deposition and sputtering, can be used for the wall surface of the breakthrough for optical paths besides electrolysis plating or nonelectrolytic plating.
[0151] In this process of (c), a roughening side may be formed in the wall surface of the metal layer which has the gloss formed in the wall surface of the breakthrough for optical paths if needed. As an approach of forming the above-mentioned roughening side, the etching processing using the etching reagent containing the second copper complex and an organic-acid salt, processing by the Cu-nickel-P needlelike alloy plating, etc. are mentioned, for example. Moreover, after forming a conductor layer by nonelectrolytic plating processing etc., a roughening side may be formed in this conductor layer, and the metal layer which has gloss so that the configuration of this roughening side may be followed may be formed. In addition, after forming a roughening side in the conductor layer formed by nonelectrolytic plating processing etc., the metal layer which has gloss with a flat front face may be formed.
[0152] Moreover, it is desirable to fill up a non-hardened resin constituent with the process of the above (c) in this breakthrough for optical paths, after forming a metal layer in a breakthrough (breakthrough for optical paths). After being filled up with a non-hardened resin constituent in the breakthrough for optical paths, it can consider as the optical path for lightwave signal transmission by which the resin layer for optical paths was formed in the interior by performing hardening processing. It is not limited especially as an approach filled up with a non-hardened resin constituent, for example, approaches, such as printing and potting, can be used. In addition, when filled up with a non-hardened resin constituent by printing, it may be filled up with the resin constituent which is not hardened [this] at once, and it may be printed in 2 steps or more. Moreover, printing may be performed from the both sides of a multilayer-interconnection plate.
[0153] Moreover, in case it is filled up with a non-hardened resin constituent, it may be filled up with the resin constituent which is not hardened [of somewhat many amounts], and the excessive resin constituent with which it overflowed from the breakthrough for optical paths may be removed from the inner product of the above-mentioned breakthrough for optical paths after restoration termination. the above — polish etc. can perform clearance of an excessive resin constituent. Moreover, what is necessary is for the condition of a resin constituent to be in a semi-hardening condition, to be in the condition hardened thoroughly, and just to choose it suitably in consideration of the presentation of a resin constituent etc., when removing an excessive resin

constituent. In addition, the same thing as the ingredient of the resin layer for optical paths explained as a resin constituent which is not hardened [above-mentioned] in the substrate for IC chip mounting which constitutes the device for optical communication of the first this invention etc. is mentioned.

[0154] While the multilayer-interconnection plate manufactured through the process of the above (a) by passing through such a through-hole formation process, a metal layer formation process, and the resin constituent restoration process performed if needed is filled up with a resin constituent to the interior, the part which penetrates the resin insulating layer between a substrate and layers of the optical path for lightwave signal transmission by which the metal layer was formed in the wall surface of the perimeter can be formed. moreover, the conductor which became independent by forming a conductor layer also in the front face of the resin insulating layer between layers, and performing processing mentioned above in case the above-mentioned metal layer formation process is performed — a circuit can be formed.

[0155] Next, the solder resist layer formation process which forms the solder resist layer which has opening which is open for free passage to the breakthrough (breakthrough for optical paths) formed at the process of the above (b) is performed if needed. Specifically, a solder resist layer can be formed by performing following (1) and the process of (2).

[0156] (1) Form the layer of a solder resist constituent in the outermost layer of drum of the multilayer-interconnection plate in which the breakthrough for optical paths was formed, first. The layer of the above-mentioned solder resist constituent can be formed using the solder resist constituent which consists of for example, polyphenylene ether resin, polyolefin resin, a fluororesin, thermoplastic elastomer, an epoxy resin, polyimide resin, etc.

[0157] moreover, as solder resist constituents other than the above For example, the acrylate (meta) of a novolak mold epoxy resin, an imidazole curing agent, 2 functionality (meta) acrylic ester monomer, the polymer of with a molecular weight of about 500 to 5000 acrylic ester (meta), The fluid of the shape of a paste containing photosensitive monomers, such as thermosetting resin which consists of a bisphenol mold epoxy resin etc., and a multiple-valued acrylic monomer, a glycol ether system solvent, etc. is mentioned, and, as for the viscosity, it is desirable to be adjusted to 1 - 10 Pa-s at 25 degrees C. Moreover, a commercial solder resist constituent may be used. Moreover, at this process, the film which consists of the above-mentioned solder resist constituent is stuck by pressure, and the layer of a solder resist constituent may be formed.

[0158] (2) Next, form opening (henceforth opening for optical paths) which was open for free passage in the layer of the above-mentioned solder resist constituent at the above-mentioned breakthrough for optical paths. Specifically, it forms by the approach of forming opening for the Bahia halls, and the same approach, i.e., an exposure development, the lasing, etc. Moreover, in case the above-mentioned opening for optical paths is formed, it is desirable simultaneously to form opening for solder bump formation (opening for mounting IC chip and an optical element and opening for connecting with external substrates, such as a multilayer printed wiring board). In addition, formation of the above-mentioned opening for optical paths and formation of the above-mentioned opening for solder bump formation are independently good in a line.

[0159] Moreover, in case a solder resist layer is formed, the solder resist layer which has opening for optical paths and opening for solder bump formation may be formed by producing the resin film which has opening in a desired location, and sticking this resin film on it beforehand. By passing through such a process of (1) and (2), the solder resist layer which has this breakthrough for optical paths and opening which was open for free passage can be formed on the multilayer-interconnection plate in which the breakthrough for optical paths was formed. In addition, the path of the above-mentioned opening for optical paths may be the same as that of the path of the above-mentioned breakthrough for optical paths, and may be smaller than the path of the above-mentioned breakthrough for optical paths.

[0160] Moreover, when the resin layer for optical paths is formed after the process of the above (c), and in the breakthrough for optical paths, it is desirable to form the resin layer for optical paths by filling up also with this process the resin constituent which is not hardened to opening for optical paths formed in the solder resist layer, and performing hardening processing after that. The resin layer for optical paths will be formed in the whole interior of the optical path for lightwave signal transmission by forming the resin layer for optical paths also in this process. Moreover, it is desirable that it is the same as that of the resin constituent which is not hardened [with which it is filled up in the above-mentioned breakthrough for optical paths as a resin constituent which is not hardened / with which it is filled up in the above-mentioned opening for optical paths].

[0161] moreover, in forming the optical path for lightwave signal transmission by which the resin layer for optical paths was formed in the whole interior It is not filled up with a non-hardened resin constituent after the process of the above (c), but sets at this process. It is good also as an optical path for lightwave signal transmission by which the resin layer for optical paths was formed in the whole interior by being filled up with a non-hardened resin constituent in opening for optical paths which was open for free passage to the inside of the breakthrough

for optical paths, and this, and performing hardening processing after that.
[0162] Moreover, after filling up the breakthrough for optical paths with a non-hardened resin constituent in the process of the above (c), The solder resist layer which has opening for optical paths by the approach which was made to carry out semi-hardening of this resin constituent, and mentioned it above after that is formed. Furthermore, after being filled up with a non-hardened resin constituent in the above-mentioned opening for optical paths, the resin layer for optical paths may be formed by performing hardening processing to the resin constituent in the breakthrough for optical paths, and the resin constituent in opening for optical paths simultaneously.
[0163] Moreover, a micro lens is arranged in the edge of the optical path for lightwave signal transmission if needed. Although what is necessary is just to arrange in the edge of the optical path for lightwave signal transmission through the adhesives layer formed on the solder resist layer in order to arrange a micro lens in the edge of the above-mentioned optical path for lightwave signal transmission, when the resin layer for optical paths is especially formed in the interior of the optical path for lightwave signal transmission, it is desirable to arrange directly on this resin layer for optical paths.
[0164] As an approach of arranging a micro lens directly on the above-mentioned resin layer for optical paths, optimum dose dropping of the non-hardened resin for optical lenses is carried out on the resin layer for optical paths, and this method of performing hardening processing etc. is mentioned to the resin for optical lenses which is not hardened [which was dropped], for example. In case optimum dose dropping of the resin for optical lenses which is not hardened [above-mentioned] is carried out on the resin layer for optical paths, equipments, such as a dispenser, an ink jet, a micropipette, and a micro syringe, can be used. Since the resin for optical lenses which is not hardened [which was dropped on the resin layer for optical paths using such equipment] tends to become a globular form with the surface tension, it becomes hemispherical on the above-mentioned resin layer for optical paths, and a semi-sphere-like micro lens can be arranged on the resin layer for optical paths by performing hardening processing to the resin for optical lenses which is not semi-sphere-like hardened after that.
[0165] The resin for optical lenses explained in the device for optical communication of the first this invention as resin for optical lenses which is not hardened [above-mentioned] and the same resin can be mentioned. In addition, a diameter of a micro lens, a configuration of a curved surface, etc. which are formed by the approach mentioned above are controllable by adjusting the viscosity of the non-hardened resin for optical lenses etc. suitably, taking into consideration the wettability of a resin constituent and the non-hardened resin for optical lenses.
[0166] moreover, the conductor exposed by forming the above-mentioned opening for solder bump formation etc. — if needed, a circuit part is covered with corrosion-resistant metals, such as nickel, palladium, gold, silver, and platinum, and let it be a solder pad. In these, it is desirable to form an enveloping layer with metals, such as nickel-gold, nickel-silver, nickel-palladium, and nickel-palladium-gold. Although the above-mentioned enveloping layer can be formed according to plating, vacuum evaporationo, electrodeposition, etc., in these, it is desirable to form with plating from the point of excelling in the homogeneity of an enveloping layer.
[0167] Moreover, after filling up the above-mentioned solder pad with soldering paste through the mask with which opening was formed in the part equivalent to opening (opening for IC chip mounting) for mounting IC chip, and opening (opening for multilayer printed wiring board connection) for connecting with external substrates, such as a multilayer printed wiring board, a solder bump is formed by carrying out a reflow. By forming such a solder bump, it becomes possible to mount IC chip or to connect external substrates, such as a multilayer printed wiring board, through this solder bump. In addition, that what is necessary is just to form if needed, even if this solder bump is the case where a solder bump is not formed, she can connect these and the substrate for IC chip mounting electrically through the bump of external substrates, such as IC chip to mount and a multilayer printed wiring board to connect.
[0168] Next, the optical element mounting process of mounting an optical element in the location which can transmit a lightwave signal through the process (opening for optical paths), i.e., the above-mentioned opening, and the above-mentioned breakthrough (breakthrough for optical paths) of the above (d) is performed.
[0169] What is necessary is for mounting of the above-mentioned optical element to fill up soldering paste with the process which fills up opening for mounting for example, the above-mentioned IC chip etc. with soldering paste also into opening (opening for optical element mounting) for mounting an optical element, and just to mount it through solder further, by attaching the above-mentioned optical element, in case a reflow is performed. Moreover, it may replace with soldering paste and an optical element may be mounted using electroconductive glue etc. In addition, as the above-mentioned optical element, the above-mentioned photo detector, the above-mentioned light emitting device, etc. are mentioned, for example. The substrate for IC chip mounting can be manufactured by passing through such a process.

[0170] Next, the manufacture approach of a multilayer printed wiring board is explained.
(1) first — the process of (1) of (a), and (2) — the same — carrying out — both sides of a substrate — a conductor — the conductor which forms a circuit and whose substrate was both pinched — form the through hole which connects between circuits. [of the manufacture approach of the above-mentioned substrate for IC chip mounting] moreover — this process — a conductor — a roughening side is formed in the front face of a circuit, or the wall surface of a through hole if needed.
[0171] (2) next, the need — responding — a conductor — a substrate [in which the circuit was formed] top — the resin insulating layer between layers, and a conductor — carry out laminating formation of the circuit. It is made concrete first to be the same as that of the process of (3) of (a), and (4). [of the manufacture approach of the above-mentioned substrate for IC chip mounting] The resin insulating layer between layers which has opening for the Bahia halls is formed, and a thin film conductor layer is further formed in the front face of the resin insulating layer between layers containing the wall surface of opening for the Bahia halls like the process of (5) of the manufacture approach of the substrate for IC chip mounting.
[0172] Next, thickness of a conductor layer is thickened by forming a electroplating layer etc. the whole surface on the above-mentioned thin film conductor layer. In addition, what is necessary is just to perform formation of a electroplating layer etc. if needed. Subsequently, etching resist is formed on the above-mentioned conductor layer. After the above-mentioned etching resist sticks for example, a photosensitive dry film, it carries out adhesion arrangement of the photo mask on this photosensitive dry film, and forms it by performing an exposure development.
[0173] furthermore, the thing which etching processing removes the above-mentioned etching-resist agenesis subordinate's conductor layer, and is exfoliated in etching resist after that — the resin insulating-layer top between layers — a conductor — a circuit (the Bahia hall is included) is formed. In addition, the above-mentioned etching processing can be performed using etching reagents, such as mixed liquor of a sulfuric acid and a hydrogen peroxide, sodium persulfate, ammonium persulfate, a ferric chloride, and a cupric chloride, and exfoliation of etching resist can be performed using an alkali water solution etc.
[0174] in addition, the conductor explained here — although the formation approach of a circuit is a subtractive process — the resin insulating-layer top between layers — a conductor — the approach same as an approach of forming a circuit as (5) - of (a) of the manufacture approach of the above-mentioned substrate for IC chip mounting (7) — using — a conductor — a circuit may be formed. moreover, this process of (2), i.e., the resin insulating layer between layers, and a conductor — the process which carries out the laminating of the circuit may be performed once, and is good in a multiple-times line.
[0175] (3) next, the conductor on the substrate for IC chip mounting, the substrate of the side which counters, or the resin insulating layer between layers — form optical waveguide in the circuit agenesis section. Formation of the above-mentioned optical waveguide can be performed by attaching beforehand the optical waveguide fabricated in the predetermined configuration through adhesives, when carrying out by using inorganic materials, such as quartz glass, for the ingredient. Moreover, the optical waveguide which consists of the above-mentioned inorganic material can be formed by making the inorganic material of LiNbO3 and LiTaO3 grade form by the liquid-phase-epitaxial method, the chemistry depositing method (CVD), a molecular beam epitaxy, etc.
[0176] Moreover, when forming the above-mentioned optical waveguide using a polymer ingredient, optical waveguide can be formed from sticking beforehand the film for optical waveguide formation fabricated in the shape of a film on the substrate or the mold releasing film on the resin insulating layer between layers, or forming directly on the resin insulating layer between layers. Specifically, it can form using the approach using reactive ion etching, the exposure developing-negatives method, the metal mold forming method, the resist forming method, the approach that combined these. In addition, these approaches can be used also when forming optical waveguide on a substrate or a mold releasing film, and forming directly on the resin insulating layer between layers.
[0177] the approach using the above-mentioned reactive ion etching — (i) — first, a lower clad is formed on a mold releasing film etc., the resin constituent for cores is applied on (ii), next this lower clad, and it considers as the resin layer for core formation by performing hardening processing further if needed. (iii) Next, a mask (etching resist) is formed on the resin layer for core formation by forming the resin layer for mask formation on the above-mentioned resin layer for core formation, and subsequently performing an exposure development to the resin layer for this mask formation.
[0178] (iv) Next, by giving reactive ion etching to the resin layer for core formation, the resin layer for core formation of a mask agenesis part is removed, and a core is formed on a lower clad. (v) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide. By the approach using this reactive ion etching, the optical waveguide excellent in dimension dependability can be formed. Moreover, this approach is excellent also in repeatability.

[0179] moreover — the exposure developing-negatives method — (i) — first, a lower clad is formed on a mold releasing film etc., the resin constituent for cores is applied on (ii), next this lower clad, and the layer of the resin constituent for core formation is further formed by performing semi-hardening if needed.
[0180] (iii) Next, a core is formed on a lower clad by laying the mask with which the pattern corresponding to a core formation part was drawn on the layer of the above-mentioned resin constituent for core formation, and performing an exposure development after that. (v) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide. Since there are few routing counters, in case this exposure developing-negatives method mass-produces optical waveguide, it can be used suitably, and since there are few heating processes, stress cannot generate it easily in optical waveguide.
[0181] moreover — the above-mentioned metal mold forming method — (i) — first, a lower clad is formed on a mold releasing film etc., and the slot for core formation is formed in (ii), next a lower clad by metal mold formation. (iii) Further, above-mentioned Mizouchi is filled up with the resin constituent for cores by printing, and a core is formed by performing hardening processing after that. (iv) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide. In case this metal mold forming method mass-produces optical waveguide, it can be used suitably, and it can form the optical waveguide excellent in dimension dependability. Moreover, this approach is excellent also in repeatability.
[0182] moreover — the above-mentioned resist forming method — (i) — first — a mold releasing film etc. top — a lower clad — forming — (ii) — further, after applying the resin constituent for resists on this lower clad, resist formation for core formation is carried out by performing an exposure development at the core agenesis part on the above-mentioned lower clad.
[0183] (iii) Next, after the resin constituent for cores applying to the resist agenesis part on a lower clad and hardening the resin constituent for cores to the (iv) pan, a core is formed on a lower clad by exfoliating the above-mentioned resist for core formation. (v) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide. In case this resist forming method mass-produces optical waveguide, it can be used suitably, and it can form the optical waveguide excellent in dimension dependability. Moreover, this approach is excellent also in repeatability. In addition, in the optical waveguide formed by these approaches, the refractive index of a core is made larger than the refractive index of a clad.
[0184] Moreover, in case optical waveguide is formed at this process, an upper part [form / further in this case / form optical waveguide directly on a substrate or the resin insulating layer between layers, and / on / whole / a substrate or the resin insulating layer between layers / using the approach of carrying out laminating formation of a lower clad and a core which were mentioned above, and the up clad one by one, / an up clad] clad can play a role of a solder resist layer. Moreover, this up clad can play a role of a solder resist layer also by forming the lower clad and the core in the shape of a film beforehand, sticking this on the position on a substrate or the resin insulating layer between layers, and forming an up clad further on [whole] the above-mentioned substrate or the resin insulating layer between layers.
[0185] Moreover, an optical-path conversion mirror is formed in the above-mentioned optical waveguide. Although it may be formed before the above-mentioned optical-path conversion mirror attaches optical waveguide on the resin insulating layer between layers, and it may be formed after attaching it on the resin insulating layer between layers, it is desirable to form an optical-path conversion mirror beforehand except for the case where this optical waveguide is directly formed on the resin insulating layer between layers. other members which can work easily and constitute a multilayer printed wiring board at the time of an activity, for example, a substrate, and a conductor — it is because a blemish is attached to a circuit, the resin insulating layer between layers, etc. or there is no possibility of damaging these.
[0186] It is not limited especially as an approach of forming the above-mentioned optical-path conversion mirror, but the well-known formation approach can be used conventionally. Specifically, machining with the diamond saw and cutter whose head is 90 degrees of V types, processing by reactive ion etching, laser ablation, etc. can be used.
[0187] (4) Next, form a solder resist layer in the outermost layer of drum of the substrate in which optical waveguide was formed, if needed. The above-mentioned solder resist layer can be formed using the resin constituent used when forming the solder resist layer of for example, the above-mentioned substrate for IC chip mounting, and the same resin constituent.
[0188] (5) Next, form opening for solder bump formation (opening for mounting the substrate for IC chip mounting, and various surface mount mold electronic parts), and opening for optical paths in the substrate for IC chip mounting, and the solder resist layer of the side which counters. Formation with the above-mentioned opening for solder bump formation and opening for optical paths can be performed to the substrate for IC chip mounting using the approach of forming opening for solder bump formation, and the same approach, i.e., an exposure development, the lasing, etc. In addition, formation of the above-mentioned opening for solder bump

formation and formation of opening for optical paths may be performed simultaneously, and are independently good in a line.
[0189] In these, in case a solder resist layer is formed, it is desirable to choose the approach of forming opening for solder bump formation and opening for optical paths by applying the resin constituent which contains a photopolymer as the ingredient, and performing an exposure development. It is because there is no possibility of attaching a blemish to the optical waveguide which exists under this opening for optical paths, at the time of opening formation in forming opening for optical paths by the exposure development. Moreover, in case a solder resist layer is formed, the solder resist layer which has opening for solder bump formation and opening for optical paths may be formed by producing the resin film which has opening in a desired location, and sticking this resin film on it beforehand.
[0190] Moreover, opening for solder bump formation may be formed also in the solder resist layer of the substrate for IC chip mounting, the field which counters, and an opposite hand if needed. By passing through an after process, it is because an external connection terminal can be formed also in the solder resist layer of the substrate for IC chip mounting, the field which counters, and an opposite hand.
[0191] (6) next, the conductor exposed by forming the above-mentioned opening for solder bump formation — if needed, a circuit part is covered with corrosion-resistant metals, such as nickel, palladium, gold, silver, and platinum, and let it be a solder pad. What is necessary is just to specifically carry out using the approach explained by the manufacture approach of the substrate for IC chip mounting, and the same approach.
[0192] (7) Next, in opening for optical paths formed at the process of the above (5), it is filled up with a non-hardened resin constituent and form the resin layer for optical paths by performing hardening processing after that if needed. In addition, as for the resin constituent which is not hardened [which is filled up with this process], it is desirable that it is the same as that of the resin constituent filled up with the production process of the substrate for IC chip mounting into the breakthrough for optical paths and opening for optical paths.
[0193] (8) Next, form a solder bump by carrying out a reflow after filling up the above-mentioned solder pad with soldering paste through the mask with which opening was formed in the part equivalent to the above-mentioned solder pad. By forming such a solder bump, it becomes possible to mount the substrate for IC chip mounting, and various surface mount mold electronic parts through this solder bump. In addition, that what is necessary is just to form if needed, even if this solder bump is the case where a solder bump is not formed, she can mount these through the bump of the substrate for IC chip mounting, or various surface mount mold electronic parts who mounts. Moreover, it is good also as PGA (Pin Grid Array) or BGA (Ball Grid Array) by not forming an external connection terminal, arranging a pin or forming a solder ball if needed, especially in the solder resist layer of the substrate for IC chip mounting, the field which counters, and an opposite hand. By passing through such a process, the multilayer printed wiring board which constitutes the device for optical communication can be manufactured.
[0194] By the manufacture approach of the device for optical communication of the fourth this invention next, between the optical element of the substrate for IC chip mounting, and the optical waveguide of a multilayer printed wiring board, both are stationed in the location which can perform transmission of a lightwave signal through the optical path for lightwave signal transmission, and it fixes to it. Here, both are fixed, while forming a solder connection by the solder bump of the above-mentioned substrate for IC chip mounting, and the solder bump of the above-mentioned multilayer printed wiring board and connecting both electrically, after carrying out opposite arrangement of the substrate for IC chip mounting, and the multilayer printed wiring board. That is, both are connected by carrying out opposite arrangement and carrying out a reflow of the substrate for IC chip mounting, and the multilayer printed wiring board to a position with the predetermined sense, respectively. In addition, as mentioned above, the solder bump for fixing both substrate for IC chip mounting and multilayer printed wiring board may be formed only in one of both.
[0195] Moreover, at this process, even if some location gap exists among both when opposite arrangement of both is carried out in order to connect the substrate for IC chip mounting, and a multilayer printed wiring board using both solder bump, both can be stationed to a position according to the self-alignment effectiveness which solder has at the time of a reflow.
[0196] Moreover, by the manufacture approach of this invention, after arranging and fixing the substrate for IC chip mounting, and a multilayer printed wiring board to a position, the resin constituent for closure may be slushed between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, and a closure resin layer may be formed in it by performing hardening processing after that.
[0197] Silicone resin mentioned above as the above-mentioned resin constituent for closure, such as polyimide resin; epoxy resin;UV hardenability epoxy resin; deuteration silicone resin, such as acrylic resin; fluorination polyimide, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA; that with which resinous principles, such as a polymer manufactured from benz-cyclo-butene, and the particle

contained if needed were resembled, in addition the curing agent, various additives, a solvent, etc. were blended suitably is mentioned. Moreover, as for the above-mentioned resin constituent for closure, it is desirable for the permeability of the communication link wavelength light after hardening to be 70% or more.
[0198] What is necessary is here, just to choose suitably in consideration of the design of the presentation of the resin constituent for closure, the substrate for IC chip mounting, and a multilayer printed wiring board etc. as the viscosity of the resin constituent for closure slushed between the substrate for IC chip mounting, and a multilayer printed wiring board, and conditions for the hardening processing after slushing this resin constituent for closure.
[0199] Next, IC chip is mounted in the substrate for IC chip mounting, and it considers as the device for optical communication by performing the resin seal of IC chip after that if needed. Mounting of the above-mentioned IC chip can be conventionally performed by the well-known approach. Moreover, it is good also as a device for optical communication by connecting the substrate for IC chip mounting and multilayer printed wiring board which performed mounting of IC chip before connecting the substrate for IC chip mounting, and a multilayer printed wiring board, and mounted IC chip.
[0200] Next, the device for optical communication of the second this invention is explained. the device for optical communication with which the device for optical communication of the second this invention consists of a substrate for IC chip mounting, and a multilayer printed wiring board -- it is -- the above-mentioned multilayer printed wiring board -- a substrate and a conductor -- [0201] characterized by to be constituted including a circuit, and for the optical path for lightwave-signal transmission which penetrates a substrate at least to be arranged by the above-mentioned multilayer printed wiring board, and to be formed the part or the metal layer which boils all and has gloss of the wall surface, as for the above-mentioned optical path for lightwave-signal transmission Since the metal layer which has the gloss formed in a part or all of a wall surface of the optical path for lightwave signal transmission can reflect suitably the lightwave signal which transmits the inside of the above-mentioned optical path for lightwave signal transmission, the device for optical communication of the second this invention is decreased because the above-mentioned lightwave signal is equivalent to the wall surface of the optical path for lightwave signal transmission, or is hard to be absorbed. Therefore, since it is hard to generate loss in the lightwave signal which transmits the inside of the optical path for lightwave signal transmission according to the device for optical communication of the second this invention, the dependability of transmission of a lightwave signal is high and exact optical communication can be realized.
[0202] In the device for optical communication of the second this invention, the optical path for lightwave signal transmission which penetrates a substrate at least is arranged by the multilayer printed wiring board which constitutes this device for optical communication. In the multilayer printed wiring board in which such an optical path for lightwave signal transmission was arranged, a lightwave signal can be transmitted through this optical path for lightwave signal transmission.
[0203] In the device for optical communication of the second this invention, the metal layer to which the above-mentioned optical path for lightwave signal transmission has gloss in a part or all of the wall surface is formed. Thus, since it is suitably reflected in the metal layer which has the above-mentioned gloss when the metal layer which has gloss was formed in a part or all of a wall surface of the optical path for lightwave signal transmission and the lightwave signal which transmits the interior of the above-mentioned optical path for lightwave signal transmission is equivalent to the wall surface of the optical path for lightwave signal transmission, it is hard to generate loss in a lightwave signal, and the dependability of lightwave-signal transmission can be raised. In addition, although the metal layer which has the above-mentioned gloss is formed in a part of wall surface of the optical path for lightwave signal transmission or is formed in all of the above-mentioned wall surfaces When the metal layer which has the above-mentioned gloss is formed in a part of wall surface of the optical path for lightwave signal transmission, as for the metal layer which has the above-mentioned gloss, it is desirable to be formed in the wall surface of the part which penetrates the substrate of the optical path for lightwave signal transmission and the resin insulating layer between layers. Usually, a substrate and the resin insulating layer between layers have high adhesion with a metal, and a solder resist layer is because adhesion with a metal is low.
[0204] Moreover, as for the above-mentioned optical path for lightwave signal transmission, being constituted including an opening is desirable. When the optical path for lightwave signal transmission is formed including the opening, while the formation is easy, in transmission of the lightwave signal through this optical path for lightwave signal transmission, it is hard to generate transmission loss. In addition, in consideration of the thickness of a multilayer printed wiring board etc., it should just determine suitably whether the configuration of the above-mentioned optical path for lightwave signal transmission is made into an opening.
[0205] Moreover, as for the above-mentioned optical path for lightwave signal transmission, being constituted including a resin constituent is also desirable. When the above-mentioned optical path for lightwave signal

transmission is constituted including the resin constituent, lowering of the reinforcement of a multilayer printed wiring board can be prevented. Moreover, if the optical path for lightwave signal transmission is constituted by the resin constituent, since it can prevent that dust, a foreign matter, etc. enter in this optical path for lightwave signal transmission, it can prevent that originate in existence of dust, a foreign matter, etc. and transmission of a lightwave signal is checked.

[0206] Moreover, as for the above-mentioned optical path for lightwave signal transmission, being constituted including a resin constituent and an opening is also desirable. When the above-mentioned optical path for lightwave signal transmission is constituted including the resin constituent and the opening, lowering of the reinforcement of a multilayer printed wiring board can be prevented. In addition, when the above-mentioned optical path for lightwave signal transmission is constituted by the resin constituent and the opening, it is desirable for the optical path for lightwave signal transmission formed in the part which penetrates a substrate and a layer insulation layer to be constituted by the resin constituent, and for the optical path for lightwave signal transmission formed in the solder resist layer to be constituted by the opening. Usually, a substrate and a layer insulation layer have high adhesion with resin, and a solder resist layer is because adhesion with resin is low.

[0207] The substrate for IC chip mounting which is not limited especially as a substrate for IC chip mounting which constitutes the above-mentioned device for optical communication, for example, constitutes the device for optical communication of the first this invention is mentioned. Moreover, the optical path for lightwave signal transmission does not necessarily need to be formed in the substrate for IC chip mounting which constitutes the device for optical communication of the second this invention. Therefore, what is necessary is just to attach in the multilayer printed wiring board of the substrate for IC chip mounting, and the side which counters through solder, electroconductive glue, etc., in mounting optical elements, such as a photo detector and a light emitting device, in the above-mentioned substrate for IC chip mounting. In this case, even if the optical path for lightwave signal transmission is not formed in the substrate for IC chip mounting, a lightwave signal can be transmitted between a photo detector, a light emitting device, and the optical waveguide formed in the multilayer printed wiring board.

[0208] Hereafter, the device for optical communication of the second this invention is explained, referring to a drawing. Drawing 3 is the sectional view showing typically 1 operation gestalt of the device for optical communication of the second this invention. In addition, the device for optical communication in the condition that IC chip was mounted is shown in drawing 3 .

[0209] As shown in drawing 3 , the device 350 for optical communication of the second this invention consists of the substrates 320 for IC chip mounting and multilayer printed wiring boards 300 which mounted the IC chip 340, and the substrate 320 for IC chip mounting and the multilayer printed wiring board 300 are electrically connected through the solder connection 341.

[0210] the mounting substrate 320 for IC chip — both sides of a substrate 321 — a conductor — the conductor with which laminating formation was carried out and the substrate 321 of the layer insulation layer [a circuit 324 and] 322 was pinched — circuits and the conductor whose layer insulation layer 322 was pinched — circuits are electrically connected by the through hole 329 and the Bahia hall 327, respectively. Moreover, the solder resist layer 334 equipped with the solder bump is formed in the outermost layer of drum of the mounting substrate 320 for IC chip, in addition the outermost layer of drum of a multilayer printed wiring board 300 and the side which counters is equipped with the photo detector 338 and the light emitting device 339 so that light sensing portion 338a and light-emitting part 339a may be exposed, respectively.

[0211] a multilayer printed wiring board 300 — both sides of a substrate 301 — a conductor — the conductor with which laminating formation was carried out and the substrate 301 of the layer insulation layer [a circuit 304 and] 302 was pinched — circuits and the conductor whose layer insulation layer 302 was pinched — circuits are electrically connected by the through hole 309 and the Bahia hall 307, respectively. Moreover, the optical path 361 for lightwave signal transmission which penetrates a substrate 301, the layer insulation layer 302, and the solder resist layer 314 is formed in the multilayer printed wiring board 300, and through this optical path 361 for lightwave signal transmission, it is constituted so that a lightwave signal can be transmitted between optical waveguide 319 (319a, 319b), and a photo detector 338 and a light emitting device 339. Furthermore, metal layer 361b is formed in a part of that wall surface, and, as for this optical path 361 for lightwave signal transmission, resin layer 361a for optical paths is formed in a part of that interior. In the multilayer printed wiring board 300, optical waveguide 319 is formed on both sides of the substrate 301 on the substrate 320 for IC chip mounting, and the layer insulation layer 302 of the outermost layer of drum of an opposite hand, and optical waveguide 319 is equipped with the optical-path conversion mirror 319 (319a, 319b). In the device 350 for optical communication shown in drawing 3 , a photo detector and a light emitting device will be mounted in a multilayer printed wiring board and the field of the side which counters.

[0212] In such a device for optical communication of the second this invention, since light / electrical signal conversion is performed, the transmission distance of an electrical signal is short and can respond to a high-speed communication link more in the location near the inside of the substrate for IC chip mounting, i.e., IC chip. moreover, the electrical signal sent out from IC chip is delivery outside through an optical fiber, after being changed into a lightwave signal, as mentioned above — it is not only carried out, but it sends to a multilayer printed wiring board through a solder connection — having — the conductor of this multilayer printed wiring board — it will be sent to electronic parts, such as other IC chips mounted in the multilayer printed wiring board, through a circuit (the Bahia hall and a through hole are included). Moreover, with the device for optical communication which consists of such a configuration, since it is hard to generate location gap in the photo detector mounted in the substrate for IC chip mounting, a light emitting device, and the optical waveguide formed in the multilayer printed wiring board, it will excel in the connection dependability of a lightwave signal.
[0213] In addition, although the formation location of the optical waveguide in the multilayer printed wiring board shown in drawing 3 is on the layer insulation layer of an outermost layer of drum, in the multilayer printed wiring board which constitutes the device for optical communication of the second this invention, the formation location of optical waveguide may not necessarily be limited here, may be between layer insulation layers, and may be on a substrate.
[0214] Moreover, in the multilayer printed wiring board 300 shown in drawing 3 , metal layer 361b which has gloss on the wall surface of the part which penetrates the substrate 301 of the optical path 361 for lightwave signal transmission and the resin insulating layer 302 between layers is formed. Thus, by the metal layer which has gloss on the wall surface of the optical path for lightwave signal transmission being formed, a lightwave signal is suitably reflected in the above-mentioned metal layer, it is hard to generate loss in a lightwave signal, and the device for optical communication of the second this invention becomes the thing excellent in the dependability of a signal transmission, in case a lightwave signal transmits the inside of the optical path for lightwave signal transmission. Moreover, the substrate for IC chip mounting which constitutes the device for optical communication of the second this invention although metal layer 361b is formed in a part of optical path 361 for lightwave signal transmission (part which penetrates a substrate 301 and the resin insulating layer 302 between layers) in the multilayer printed wiring board 300 shown in drawing 3 may be the structure where the metal layer was formed in all of the wall surfaces of for example, the optical path for lightwave signal transmission.
[0215] In addition, since construction material, such as an optical path for lightwave signal transmission in the device for optical communication of the second this invention, an optical element, and optical waveguide, etc. is almost the same as that of the thing of the device for optical communication of the first this invention, suppose that it is omitted about the explanation. The device for optical communication of the second this invention which consists of such a configuration can be manufactured using the manufacture approach of the device for optical communication of the fifth this invention mentioned later, for example.
[0216] Next, the manufacture approach of the device for optical communication of the fifth this invention is explained. The manufacture approach of the device for optical communication of the fifth this invention the substrate for IC chip mounting with which the optical element was mounted — manufacturing — this — another — both sides of the (A) substrate — a conductor — with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the resin insulating layer between layers, and is used as a multilayer-interconnection plate (B) The through-hole formation process which forms a breakthrough in the above-mentioned multilayer-interconnection plate, and the metal layer formation process which forms the metal layer which has gloss on the wall surface of the (C) above-mentioned breakthrough, (D) After manufacturing a multilayer printed wiring board using the approach containing the optical waveguide formation process which forms optical waveguide in the location which can transmit a lightwave signal through the above-mentioned breakthrough, It is characterized by stationing both in the location which can perform transmission of a lightwave signal, and fixing to it between the optical element of the above-mentioned substrate for IC chip mounting, and the optical waveguide of the above-mentioned multilayer printed wiring board.
[0217] In the multilayer printed wiring board which constitutes the device for optical communication manufactured by the manufacture approach of the device for optical communication of the fifth this invention Since the metal layer which has gloss in a part or all of the optical path for lightwave signal transmission is formed and this metal layer can reflect suitably the lightwave signal which transmits the inside of the above-mentioned optical path for lightwave signal transmission, It decreases because the above-mentioned lightwave signal is equivalent to the wall surface of the optical path for lightwave signal transmission, or it is hard to be absorbed, and since it is hard to generate loss in the lightwave signal which transmits the inside of the optical path for lightwave signal transmission, the dependability of transmission of a lightwave signal is high and exact optical communication can be realized. Therefore, according to the manufacture approach of the device for optical communication of the fifth this invention, the connection loss between the mounted optics is low, and the

device for optical communication which is excellent in connection dependability can be manufactured.
[0218] First, the device for optical communication of the fifth this invention can also manufacture independently the substrate for IC chip mounting, and a multilayer printed wiring board, and can manufacture both by connecting through solder etc. after that. [as well as the manufacture approach of the device for optical communication of the fourth this invention] Therefore, how to manufacture each of the substrate for IC chip mounting and a multilayer printed wiring board is explained independently first, and how to connect both is explained after that here.
[0219] As an approach of manufacturing the above-mentioned substrate for IC chip mounting, the approach of manufacturing the substrate for IC chip mounting in the manufacture approach of the device for optical communication of the fourth this invention, the same approach, etc. can be used, for example. In addition, as mentioned above, in the manufacture approach of the device for optical communication of the fifth this invention, the optical path for lightwave signal transmission does not need to be arranged by the substrate for IC chip mounting. therefore, in manufacturing the substrate for IC chip mounting with which the optical path for lightwave signal transmission is not formed For example, what is necessary is not to perform the process of (b) but just to form opening for optical element mounting further if needed in the approach of manufacturing the substrate for IC chip mounting in the manufacture approach of the device for optical communication of the fifth this invention, without forming opening for optical paths in the process of (c). Moreover, what is necessary is just to perform formation of a solder resist layer if needed, when forming the above-mentioned substrate for IC chip mounting.
[0220] As an approach of manufacturing the above-mentioned multilayer printed wiring board, the approach of performing the process of following the (1) - (5) etc. can be used, for example.
(1) Manufacture the multilayer-interconnection plate with which the breakthrough for optical paths was formed using the same approach as the process of (a) of the manufacture approach of the substrate for IC chip mounting, and (b) in the manufacture approach of the device for optical communication of the fourth this invention.
[0221] (2) next, the conductor on the layer insulation layer of the above-mentioned multilayer-interconnection plate — form optical waveguide in the circuit agenesis section. This optical waveguide is formed in the location which can transmit a lightwave signal through the breakthrough for optical paths. In addition, the approach of using at the process of (3) of the approach of manufacturing the multilayer printed wiring board in the manufacture approach of the device for optical communication of the fourth this invention as the formation approach of concrete optical waveguide, the same approach, etc. can be used. Moreover, an optical-path conversion mirror is formed in the optical waveguide formed here.
[0222] (3) Next, form a solder resist layer in the outermost layer of drum of the multilayer-interconnection plate in which optical waveguide was formed. What is necessary is just to form the above-mentioned solder resist layer using the approach of using at the process of (4) of the approach of manufacturing the multilayer printed wiring board in the manufacture approach of the device for optical communication of the fourth this invention, the same approach, etc. In addition, what is necessary is just to perform formation of the above-mentioned solder resist layer if needed.
[0223] (4) Next, form opening for solder bump formation, and opening for optical paths in the substrate for IC chip mounting, and the solder resist layer of the side which counters. What is necessary is just to form using the approach as the approach of using at the process of (5) of the approach of manufacturing the multilayer printed wiring board in the manufacture approach of the device for optical communication of the fourth this invention that the above-mentioned opening for solder bump formation and opening for optical paths are the same etc. Moreover, the above-mentioned opening for optical paths is formed so that it may be open for free passage to the breakthrough for optical paths formed at the process of the above (1). Moreover, after forming opening for optical paths, a resin constituent may be filled up with this process in opening for optical paths. The thing same as the above-mentioned resin constituent as the resin constituent filled up with the process of the above (1) into the breakthrough for optical paths etc. is mentioned. A resin constituent may be simultaneously filled up with this process into the breakthrough for optical paths, and opening for optical paths.
[0224] (5) Next, a multilayer printed wiring board can be manufactured by forming a solder pad, a solder bump, etc. using the approach of using at (6) of an approach and the process of (8) of manufacturing the multilayer printed wiring board in the manufacture approach of the device for optical communication of the fourth this invention, the same approach, etc.
[0225] Next, the substrate for IC chip mounting and multilayer printed wiring board which were manufactured by the above-mentioned approach are connected, and the device for optical communication is manufactured. What is necessary is just to carry out using the approach specifically used when manufacturing the device for optical communication of the fourth this invention, and the same approach. Moreover, as for the above-mentioned

substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, the solder bump may be formed only in either like the case where the device for optical communication of the fourth this invention is manufactured, among the field which counters. It is because both are connectable also in this case.

[0226] Next, the device for optical communication of the third this invention is explained. The device for optical communication of the third this invention is a device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board. To the above-mentioned substrate for IC chip mounting The optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting is arranged. The above-mentioned multilayer printed wiring board a substrate and a conductor — it is characterized by being constituted including a circuit, forming in the above-mentioned multilayer printed wiring board the optical path for lightwave signal transmission which penetrates a substrate at least, and forming the part or the metal layer which boils all and has gloss of the wall surface, as for the above-mentioned optical path for lightwave signal transmission.

[0227] Since the metal layer which has the gloss formed in a part or all of a wall surface of the optical path for lightwave signal transmission can reflect suitably the lightwave signal which transmits the inside of the above-mentioned optical path for lightwave signal transmission, the device for optical communication of the third this invention is decreased because the above-mentioned lightwave signal is equivalent to the wall surface of the optical path for lightwave signal transmission, or is hard to be absorbed. Therefore, since it is hard to generate loss in the lightwave signal which transmits the inside of the optical path for lightwave signal transmission according to the device for optical communication of the third this invention, the dependability of transmission of a lightwave signal is high and exact optical communication can be realized.

[0228] In the device for optical communication of the third this invention, the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting is arranged by the substrate for IC chip mounting which constitutes the device for optical communication, and the optical path for lightwave signal transmission which penetrates a substrate at least to the multilayer printed wiring board which constitutes the device for optical communication is arranged. In the device for optical communication of the third this invention in which such an optical path for lightwave signal transmission was arranged, a lightwave signal can be transmitted through the optical path for lightwave signal transmission arranged by the above-mentioned substrate for IC chip mounting, and the optical path for lightwave signal transmission arranged by the above-mentioned multilayer printed wiring board.

[0229] In the device for optical communication of the third this invention, the metal layer which has gloss in a part or all of the wall surface is formed in the above-mentioned optical path for lightwave signal transmission. Thus, since it is suitably reflected in the metal layer which has the above-mentioned gloss when the metal layer which has gloss was formed in a part or all of a wall surface of the optical path for lightwave signal transmission and the lightwave signal which transmits the interior of the above-mentioned optical path for lightwave signal transmission is equivalent to the wall surface of the optical path for lightwave signal transmission, it is hard to generate loss in a lightwave signal, and the dependability of lightwave-signal transmission can be raised. In addition, although the metal layer which has the above-mentioned gloss is formed in a part of wall surface of the optical path for lightwave signal transmission or is formed in all of the above-mentioned wall surfaces When the metal layer which has the above-mentioned gloss is formed in a part of wall surface of the optical path for lightwave signal transmission, as for the metal layer which has the above-mentioned gloss, it is desirable to be formed in the wall surface of the part which penetrates the substrate of the optical path for lightwave signal transmission and the resin insulating layer between layers. Usually, a substrate and the resin insulating layer between layers have high adhesion with a metal, and a solder resist layer is because adhesion with a metal is low.

[0230] Moreover, as for the above-mentioned optical path for lightwave signal transmission, being constituted including an opening is desirable. When the optical path for lightwave signal transmission is formed including the opening, while the formation is easy, in transmission of the lightwave signal through this optical path for lightwave signal transmission, it is hard to generate transmission loss. In addition, in consideration of the thickness of the substrate for IC chip mounting, or a multilayer printed wiring board etc., it should just determine suitably whether the configuration of the above-mentioned optical path for lightwave signal transmission is made into an opening.

[0231] Moreover, as for the above-mentioned optical path for lightwave signal transmission, being constituted including a resin constituent is also desirable. When the above-mentioned optical path for lightwave signal transmission is constituted including the resin constituent, lowering of the reinforcement of the substrate for IC chip mounting or a multilayer printed wiring board can be prevented. Moreover, if the optical path for lightwave signal transmission is constituted by the resin constituent, since it can prevent that dust, a foreign matter, etc. enter in this optical path for lightwave signal transmission, it can prevent that originate in existence of dust, a

foreign matter, etc. and transmission of a lightwave signal is checked.
[0232] Moreover, as for the above-mentioned optical path for lightwave signal transmission, being constituted including a resin constituent and an opening is also desirable. When the above-mentioned optical path for lightwave signal transmission is constituted including the resin constituent and the opening, lowering of the reinforcement of the substrate for IC chip mounting or a multilayer printed wiring board can be prevented. In addition, when the above-mentioned optical path for lightwave signal transmission is constituted by the resin constituent and the opening, it is desirable for the optical path for lightwave signal transmission formed in the part which penetrates a substrate and a layer insulation layer to be constituted by the resin constituent, and for the optical path for lightwave signal transmission formed in the solder resist layer to be constituted by the opening. Usually, a substrate and a layer insulation layer have high adhesion with resin, and a solder resist layer is because adhesion with resin is low.
[0233] The same thing as the substrate for IC chip mounting which will not be limited especially if the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting is formed as a substrate for IC chip mounting which constitutes the device for optical communication of the third this invention, for example, constitutes the device for optical communication of the first this invention etc. is mentioned. The various effectiveness mentioned above can be acquired by using such a substrate for IC chip mounting.
[0234] as the multilayer printed wiring board which constitutes the device for optical communication of the third this invention — a substrate and a conductor — the same thing as the multilayer printed wiring board which is constituted including the circuit, will not be limited especially if the optical path for lightwave signal transmission which penetrates the above-mentioned substrate further at least is formed, for example, constitutes the device for optical communication of the second this invention etc. is mentioned. The various effectiveness mentioned above can be acquired by using such a multilayer printed wiring board.
[0235] Since the optical path for lightwave signal transmission is formed in the substrate for IC chip mounting, and the multilayer printed wiring board, in case an optical element is mounted in the substrate for IC chip mounting or optical waveguide is formed in a multilayer printed wiring board, the degree of freedom of the mounting position of an optical element or the formation location of optical waveguide will increase, and, specifically, the densification of the substrate for IC chip mounting and a multilayer printed wiring board can be achieved. This is because a free space becomes large in the design of the substrate for IC chip mounting, and a multilayer printed wiring board.
[0236] Moreover, since optical processing and a mechanical process can perform alignment of the mounting position of an optical element, or the formation location of optical waveguide on the basis of the optical path for lightwave signal transmission formed in each of the above-mentioned substrate for IC chip mounting, and a multilayer printed wiring board, an optical element and optical waveguide can be correctly mounted in a desired location. Furthermore, in the bottom of a heat treatment process or a reliability trial, the adverse effect by heat etc. cannot generate the optical path for lightwave signal transmission of a configuration as mentioned above easily.
[0237] Hereafter, the device for optical communication of the third this invention is explained, referring to a drawing. Drawing 4 is the sectional view showing typically 1 operation gestalt of the device for optical communication of the third this invention. In addition, drawing 4 shows the device for optical communication in the condition that IC chip was mounted.
[0238] As shown in drawing 4 , the device 450 for optical communication of the third this invention consists of the substrates 420 for IC chip mounting and multilayer printed wiring boards 400 which mounted the IC chip 440, and the substrate 420 for IC chip mounting and the multilayer printed wiring board 400 are electrically connected through the solder connection 441.
[0239] Moreover, in the device 450 for optical communication, the optical path 451 for lightwave signal transmission which penetrates this is formed in the substrate 420 for IC chip mounting, metal layer 451b is formed in a part of that wall surface, and, as for this optical path 451 for lightwave signal transmission, resin layer 451a for optical paths is further formed in a part of that interior. The configuration of this substrate 420 for IC chip mounting is the same as the configuration of the substrate 220 for IC chip mounting shown in drawing 1 .

[0240] Moreover, the optical path 461 for lightwave signal transmission which penetrates a substrate 401, the layer insulation layer 402, and the solder resist layer 414 is formed in the multilayer printed wiring board 400, and through this optical path 461 for lightwave signal transmission, it is constituted so that a lightwave signal can be transmitted between optical waveguide 419, and a photo detector 438 and a light emitting device 439. Metal layer 461b is formed in a part of that wall surface, and, as for this optical path 461 for lightwave signal transmission, resin layer 461a for optical paths is further formed in a part of that interior. The configuration of this multilayer printed wiring board 400 is the same as the configuration of the multilayer printed wiring board

300 shown in drawing 2 . In this device 450 for optical communication, a photo detector 438, a light emitting device 439, and optical waveguide 419 can transmit a lightwave signal through the optical path 461 for lightwave signal transmission which penetrates the optical path 451 for lightwave signal transmission which was formed in the substrate 420 for IC chip mounting, and which penetrates this, and the substrate 401 and the layer insulation layer 402 which were formed in the multilayer printed wiring board 400, and the solder resist layer 414. Moreover, the operation gestalt of the device for optical communication of the third this invention may not be limited to the gestalt shown in drawing 4 , and may be a gestalt as shown in drawing 5 and 6.

[0241] In the substrate 550 for IC chip mounting shown in drawing 5 , the photo detector 538 is mounted in the multilayer printed wiring board 500 of the substrate 520 for IC chip mounting, and the field of the side which counters, and the light emitting device 539 is mounted in the multilayer printed wiring board 500, the field of the side which counters, and the field of an opposite hand. Moreover, the optical path 551 for lightwave signal transmission which penetrates the substrate 520 for IC chip mounting is formed so that a lightwave signal can be transmitted between the optical waveguides by which the light emitting device 539 was formed in the multilayer printed wiring board 500. Metal layer 551b is formed in a part of the wall surface, and, as for the optical path 551 for lightwave signal transmission, a part of the interior is filled up with resin layer 551a for optical paths.

[0242] Moreover, optical waveguide is formed in the multilayer printed wiring board 500. Optical waveguide 518a for transmitting a lightwave signal between photo detectors 538 Optical waveguide 518b for being formed on both sides of the substrate 501 on the layer insulation layer 502 of the outermost layer of drum of the side near the substrate 520 for IC chip mounting, and transmitting a lightwave signal between light emitting devices 539 On both sides of the substrate 501, it is formed on the substrate 520 for IC chip mounting, and the layer insulation layer 502 of the outermost layer of drum of an opposite hand. Furthermore, the optical path 561 for lightwave signal transmission for transmitting a lightwave signal between a light emitting device 539 and optical waveguide 518b is formed in the multilayer printed wiring board 500. The optical path 561 for lightwave signal transmission is formed so that a substrate 501, the layer insulation layer 502, and the solder resist layer 514 may be penetrated, metal layer 561b is formed in a part of the wall surface, and a part of the interior is filled up with resin layer 561a for optical paths.

[0243] In this device 550 for optical communication, a light emitting device 539 and optical waveguide 519b can transmit a lightwave signal through the optical path 561 for lightwave signal transmission which penetrates the optical path 551 for lightwave signal transmission which was formed in the substrate 520 for IC chip mounting, and which penetrates this, and the substrate 501 and the layer insulation layer 502 which were formed in the multilayer printed wiring board 500, and the solder resist layer 514. In addition, a photo detector 538 and optical waveguide 519a can transmit a lightwave signal through opening 511a for optical paths formed in the solder resist layer of a multilayer printed wiring board 500.

[0244] Moreover, in the device 650 for optical communication shown in drawing 6 , the photo detector 638 is mounted in the multilayer printed wiring board 600 of the substrate 620 for IC chip mounting, the field of the side which counters, and the field of an opposite hand, and the light emitting device 639 is mounted in the multilayer printed wiring board 600 and the near field where it counters. Moreover, the optical path 651 for lightwave signal transmission which penetrates the substrate 620 for IC chip mounting is formed so that a lightwave signal can be transmitted between optical waveguide 618a by which the photo detector 638 was formed in the multilayer printed wiring board 600. Metal layer 651b is formed in a part of that wall surface, and, as for this optical path 651 for lightwave signal transmission, a part of that interior is filled up with resin layer 651a for optical paths.

[0245] Moreover, optical waveguide 618a for optical waveguide 619 being formed in the multilayer printed wiring board 600, and transmitting a lightwave signal to it between photo detectors 638 Optical waveguide 618b for being formed on both sides of the substrate 601 on the layer insulation layer of the outermost layer of drum of the side near the substrate 620 for IC chip mounting, and transmitting a lightwave signal between light emitting devices 639 On both sides of the substrate 601, it is formed on the substrate 620 for IC chip mounting, and the layer insulation layer of the outermost layer of drum of an opposite hand. Furthermore, the optical path 651 for lightwave signal transmission for transmitting a lightwave signal between a light emitting device 639 and optical waveguide 618b is formed in the multilayer printed wiring board 600. The optical path 661 for lightwave signal transmission is formed so that a substrate 601, the layer insulation layer 602, and the solder resist layer 614 may be penetrated, metal layer 661b is formed in a part of the wall surface, and a part of the interior is filled up with resin layer 661a for optical paths.

[0246] In this device 650 for optical communication, a light emitting device 639 and optical waveguide 619b can transmit a lightwave signal through the optical path 661 for lightwave signal transmission which penetrates the substrate 601 and the layer insulation layer 602 which were formed in the multilayer printed wiring board 600, and the solder resist layer 614. Moreover, a photo detector 638 and optical waveguide 619a can transmit a

lightwave signal through the optical path 651 for lightwave signal transmission which was formed in the substrate 620 for IC chip mounting and which penetrates this.
[0247] In addition, as mentioned above, the operation gestalt of the device for optical communication of the third this invention should just be a gestalt which chose suitably whether it would not necessarily be limited to the gestalt shown in drawing 4 -6, and the mounting position of a photo detector or a light emitting device, the formation location of optical waveguide, and the optical path for lightwave signal transmission would be formed, and combined it.
[0248] In addition, although the formation location of the optical waveguide in the multilayer printed wiring board shown in drawing 4 -6 is on the layer insulation layer of an outermost layer of drum, in the multilayer printed wiring board which constitutes the device for optical communication of the third this invention, the formation location of optical waveguide may not necessarily be limited here, may be between layer insulation layers, and may be on a substrate.
[0249] In addition, since construction material, such as an optical path for lightwave signal transmission in the device for optical communication of the third this invention, an optical element, and optical waveguide, etc. is almost the same as that of the thing of the device for optical communication of the first this invention, suppose that it is omitted about the explanation. The device for optical communication of the third this invention which consists of such a configuration can be manufactured using the manufacture approach of the device for optical communication of the sixth this invention mentioned later, for example.
[0250] Next, the manufacture approach of the device for optical communication of the sixth this invention is explained. The manufacture approach of the device for optical communication of the sixth this invention (a) — both sides of a substrate — a conductor — with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the resin insulating layer between layers, and is used as a multilayer-interconnection plate (b) The through-hole formation process which forms a breakthrough in the above-mentioned multilayer-interconnection plate, and the metal layer formation process which forms the metal layer which has gloss on the wall surface of the (c) above-mentioned breakthrough, (d) The substrate for IC chip mounting is manufactured using an approach including the optical element mounting process of mounting an optical element in the location which can transmit a lightwave signal through the above-mentioned breakthrough. this — another — both sides of the (A) substrate — a conductor — with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the resin insulating layer between layers, and is used as a multilayer-interconnection plate (B) The through-hole formation process which forms a breakthrough in the above-mentioned multilayer-interconnection plate, and the metal layer formation process which forms the metal layer which has gloss on the wall surface of the (C) above-mentioned breakthrough, (D) After manufacturing a multilayer printed wiring board using the approach containing the optical waveguide formation process which forms optical waveguide in the location which can transmit a lightwave signal through the above-mentioned breakthrough, It is characterized by stationing both in the location which can perform transmission of a lightwave signal, and fixing to it between the optical element of the above-mentioned substrate for IC chip mounting, and the optical waveguide of the above-mentioned multilayer printed wiring board.
[0251] In the substrate for IC chip mounting and multilayer printed wiring board which constitute the device for optical communication manufactured by the manufacture approach of the device for optical communication of the sixth this invention Since the metal layer which has gloss is formed in the part or all, respectively and this metal layer can reflect suitably the lightwave signal which transmits the inside of the above-mentioned optical path for lightwave signal transmission, It decreases because the above-mentioned lightwave signal is equivalent to the wall surface of the optical path for lightwave signal transmission, or it is hard to be absorbed, and since it is hard to generate loss in the lightwave signal which transmits the inside of the optical path for lightwave signal transmission, the dependability of transmission of a lightwave signal is high and exact optical communication can be realized. Therefore, according to the manufacture approach of the device for optical communication of the sixth this invention, the connection loss between the mounted optics is low, and the device for optical communication which is excellent in connection dependability can be manufactured. As well as the manufacture approach of the device for optical communication of the fourth this invention when manufacturing the above-mentioned device for optical communication, first, the substrate for IC chip mounting and a multilayer printed wiring board can be manufactured independently, and both can be manufactured by connecting through solder etc. after that. Therefore, how to manufacture each of the substrate for IC chip mounting and a multilayer printed wiring board is explained first, and how to connect both is explained after that here.
[0252] As an approach of manufacturing the above-mentioned substrate for IC chip mounting, the approach of manufacturing the substrate for IC chip mounting in the manufacture approach of the device for optical communication of the fourth this invention, the same approach, etc. can be used, for example. What is necessary is just to perform formation of a solder resist layer if needed, when forming the above-mentioned substrate for

IC chip mounting.
[0253] As an approach of manufacturing the above-mentioned multilayer printed wiring board, the approach of manufacturing the multilayer printed wiring board in the manufacture approach of the device for optical communication of the fifth this invention, the same approach, etc. can be used, for example. What is necessary is just to perform formation of a solder resist layer if needed, when forming the above-mentioned multilayer printed wiring board.
[0254] Next, it connects with the substrate for IC chip mounting and multilayer printed wiring board which were manufactured by the above-mentioned approach, and the device for optical communication is manufactured. What is necessary is just to specifically perform the device for optical communication of the fourth this invention using the approach used by the manufacture approach, the same approach, etc.
[0255] In addition, although IC chip mounted by the manufacture approach of the device for optical communication of the fourth - the sixth this invention may be mounted by wirebonding and mounted by flip chip bonding, it is desirable that it is what is mounted by flip chip bonding.
[0256]
[Example] Hereafter, this invention is further explained to a detail.
(Example 1)
A. The production bisphenol A mold epoxy resin (weight-per-epoxy-equivalent 469, Epicoat 1001 by oil-ized shell epoxy company) 30 weight section of the resin film for the resin insulating layers between production A-1. layers of the substrate for IC chip mounting, The cresol novolak mold epoxy resin (weight-per-epoxy-equivalent 215, Epiclon N-673 by Dainippon Ink & Chemicals, Inc.) 40 weight section, The triazine structure content phenol novolak resin (phenol nature hydroxyl equivalent 120, Dainippon Ink & Chemicals, Inc. make FENO light KA-7052) 30 weight section The ethyl diethylene glycol acetate 20 weight section, The heating dissolution is carried out stirring in the solvent naphtha 20 weight section. There The end epoxidation polybutadiene rubber (Nagase Brothers formation DENAREKKUSU R-45 by industrial company EPT) 15 weight section, and the 2-phenyl -4, the 5-screw (hydroxymethyl) imidazole grinding article 1.5 weight section, The pulverizing silica 2 weight section and the silicone system defoaming agent 0.5 weight section were added, and the epoxy resin constituent was prepared. After applying using a roll coater so that the thickness after drying the obtained epoxy resin constituent on a PET film with a thickness of 38 micrometers may be set to 50 micrometers, the resin film for the resin insulating layers between layers was produced by making it dry for 10 minutes at 80-120 degrees C.
[0257] The mean particle diameter by which coating of the silane coupling agent was carried out to the preparation bisphenol female mold epoxy monomer (oil-ized shell company make, molecular weight : 310 YL983U) 100 weight section of the resin constituent for breakthrough restoration and a front face A-2. By 1.6 micrometers the diameter of grain of maximum size — SiO2 spherical particle (the Adtec Corp. make —) 15 micrometers or less CRS The viscosity prepared the resin filler of 45 - 49 Pa-s at 23**1 degree C by carrying out stirring mixing of the 1101-CE170 weight section and the leveling agent (Sannopuko PERENORU S4) 1.5 weight section for a container. In addition, the imidazole curing agent (Shikoku formation shrine make, 2E4 MZ-CN) 6.5 weight section was used as a curing agent.
[0258] A-3. Copper clad laminate which 18-micrometer copper foil 28 laminates to both sides of the insulating substrate 21 which consists of the glass epoxy resin with a manufacture (1) thickness of 0.8mm or BT (bismaleimide triazine) resin of the substrate for IC chip mounting was used as the start ingredient (refer to drawing 7 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and nonelectrolytic plating processing is performed, and is etched in the shape of a pattern — both sides of a substrate 21 — a conductor — the circuit 24 and the through hole 29 were formed (refer to drawing 7 (b)).
[0259] (2) Wash in cold water the substrate in which the circuit 24 was formed. a through hole 29 and a conductor — NaOH (10 g/l), NaClO2 after drying (40 g/l), the water solution containing Na3P O4 (6 g/l) — melanism — the melanism made into a bath (oxidation bath) — the conductor which performs reduction processing which makes a reduction bath processing and NaOH (10 g/l), and the water solution containing NaBH4 (6g/(l.)), and includes a through hole 29 — the roughening side (not shown) was formed in the front face of a circuit 24.
[0260] (3) the following approach after preparing the resin filler indicated to the above A-2 — after preparation — less than 24 hours — the conductor of one side of the inside of a through hole 29, and a substrate 21 — the circuit agenesis section and a conductor — the layer of resin filler 30' was formed in the rim section of a circuit 24. That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor — the conductor with which the part equivalent to the circuit agenesis section lays on a substrate the mask which carried out opening, and serves as a crevice using the squeegee — the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 30' was formed by making it dry on 100 degrees C and the conditions for 20 minutes (refer to drawing 7

(c)).
[0261] (4) the belt sander [one side / which finished processing of the above (3) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 — a conductor — it ground so that resin filler 30' might remain neither in the front face of a circuit 24, nor the land front face of a through hole 29, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate. Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 30 was formed.
[0262] thus, a through hole 29 and a conductor — the surface section of the resin filler 30 formed in the circuit agenesis section, and a conductor — the front face of a circuit 24 — flattening — carrying out — the resin filler 30 and a conductor — the insulating substrate which the side face of a circuit 24 stuck firmly through the roughening side, and the internal surface and the resin filler 30 of a through hole 29 stuck firmly through the roughening side was obtained (refer to drawing 7 (d)). this process — the front face of the resin filler layer 30, and a conductor — the front face of a circuit 24 turns into the same flat surface.
[0263] (5) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate — carrying out — subsequently — an etching reagent — both sides of a substrate — a spray — spraying — a conductor — etching the front face of a circuit 24, and the land front face of a through hole 29 — a conductor — the roughening side (not shown) was formed in all the front faces of a circuit 24. As an etching reagent, the etching reagent (the product made from MEKKU, MEKKU dirty bond) containing the imidazole copper (II) complex 10 weight section, the glycolic-acid 7 weight section, and the potassium chloride 5 weight section was used.
[0264] (6) Next, the somewhat larger resin film for the resin insulating layers between layers than the substrate produced by the above A-1 was laid on the substrate, and after carrying out temporary sticking by pressure and judging on pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for sticking-by-pressure time amount 10 seconds, the resin insulating layer 22 between layers was formed by sticking using vacuum laminator equipment by the approach of further the following (refer to drawing 7 (e)). That is, on the substrate, actual sticking by pressure was carried out on the degree of vacuum of 65Pa, pressure 0.4MPa, temperature 80, and the conditions for time amount 60 seconds, and heat curing of the resin film for the resin insulating layers between layers was carried out for 30 minutes at 170 degrees C after that.
[0265] (7) Next, the opening 26 for the Bahia halls with a diameter of 80 micrometers was formed in the resin insulating layer 22 between layers by CO2 gas laser with a wavelength of 10.4 micrometers through the mask with which the breakthrough with a thickness of 1.2mm was formed on the resin insulating layer 22 between layers on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the breakthrough of a mask, and the conditions of one shot (refer to drawing 8 (a)).
[0266] (8) The roughening side (not shown) was formed in the front face containing the internal surface of the opening 26 for the Bahia halls by immersing the substrate in which the opening 26 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing the permanganic acid of 60 g/l, and carrying out dissolution clearance of the epoxy resin particle which exists in the front face of the resin insulating layer 22 between layers.
[0267] (9) Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI). Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out the surface roughening process (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 26 for the Bahia halls to be included) of the resin insulating layer 22 between layers by giving a palladium catalyst (not shown). That is, the above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride (PdCl2) and a stannous chloride (SnCl2), and the catalyst was given by depositing a palladium metal.
[0268] (10) Next, into the non-electrolytic copper plating water solution of the following presentations, the substrate was immersed and the non-electrolytic copper plating film 32 with a thickness of 0.6-3.0 micrometers was formed on the front face (the internal surface of the opening 26 for the Bahia halls is included) of the resin insulating layer 22 between layers (refer to drawing 8 (b)).
[0269]
[Nonelectrolytic plating water solution]
NiSO4 0.003 mol/l tartaric acid 0.200 mol/l copper sulfate 0.030 mol/lHCHO 0.050 mol/lNaOH 0.100 mol/lalpha and alpha'-bipyridyl 100 mg/l polyethylene glycol (PEG) 0.10 g/l [nonelectrolytic plating conditions]
It is 40 minutes [0270] by whenever [30-degree C solution temperature]. (11) Next, the plating resist 23 with a thickness of 20 micrometers was formed by sticking a commercial photosensitive dry film on the substrate with which the non-electrolytic copper plating film 32 was formed, laying a mask, exposing by 100 mJ/cm2, and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 8 (c)).

[0271] (12) Subsequently, 50-degree C water washed the substrate and it degreased, with 25-degree C water, after washing with the sulfuric acid further after rinsing, electrolysis plating was performed on condition that the following, and the electrolytic copper plating film 33 with a thickness of 20 micrometers was formed in the plating-resist 23 agenesis section (refer to drawing 8 (d)).
[0272] [Electrolysis plating liquid]
Sulfuric acid 2.24 mol/l copper sulfate 0.26 mol/l additive 19.5 ml/l (made in ATOTEKKU Japan, KAPARASHIDO GL)
[Electrolysis plating conditions]
Current density 1 A/dm 2 hours 65 Part temperature 22**2 ** [0273] (13) — a conductor with a thickness of 18 micrometers which carries out etching processing of the nonelectrolytic plating film under plating resist 23 with the mixed liquor of a sulfuric acid and a hydrogen peroxide, carries out dissolution clearance and consists of non-electrolytic copper plating film 32 and electrolytic copper plating film 33 further after carrying out exfoliation clearance of the plating resist 23 by NaOH 5% — the circuit 25 (the Bahia hall 27 is included) was formed (refer to drawing 9 (a)).
[0274] A roughening side (not shown) is formed in the front face of a circuit 25. (14) — the still more nearly same etching reagent as the etching reagent used at the process of the above (5) — using — a conductor — subsequently The above (6) It has the opening 26 for the Bahia halls like the process of – (8), and laminating formation of the resin insulating layer 22 between layers by which the roughening side (not shown) was formed in the front face was carried out (refer to drawing 9 (b)). Then, the breakthrough 46 for optical paths which penetrates a substrate 21 and the resin insulating layer 22 between layers was formed using the drill with a diameter of 300 micrometers, and DESUMIA processing was further performed to the wall surface of the breakthrough 46 for optical paths (refer to drawing 9 (c)). In addition, the diameter of the drill used in case the breakthrough for optical paths is formed had desirable 200-400 micrometers, and the drill whose diameter is 300 micrometers was used for it by this example.
[0275] (15) Next, give a catalyst to the wall surface of the breakthrough 46 for optical paths, and the front face of the resin insulating layer 22 between layers by the approach used at the process of the above (9), and the same approach. Furthermore, in the nonelectrolytic plating liquid used at the process of the above (10), and the same non-electrolytic copper plating water solution The substrate was immersed and the thin film conductor layer (non-electrolytic copper plating film) 32 was formed in the front face (the internal surface of the opening 26 for the Bahia halls is included) of the resin insulating layer 22 between layers, and the wall surface of the breakthrough 46 for optical paths (refer to drawing 10 (a)).
[0276] (16) Next, form plating resist 38 in the whole (except for thin film conductor-layer 32 part formed in the wall surface of the breakthrough 46 for optical paths) front face of the resin insulating layer 22 between layers by the approach used at the process of the above (11), and the same approach. A gold cyanide potassium (7.6x10 to 3 mol/l.), an ammonium chloride (1.9x10 to 1 mol/l.), It was immersed in the non-electrolyzed gilding liquid containing a sodium citrate (1.2x10-1 mol/l) and sodium hypophosphite (1.7x10-1 mol/l) for 7.5 minutes on 80-degree C conditions, and the metal layer (gilding layer) 45 was formed in the wall surface of the breakthrough 46 for optical paths. Then, exfoliation clearance of the plating resist 38 was carried out by NaOH 5%.
[0277] (17) Next, plating resist 23 was formed in the part which contains the end-face part of the breakthrough for optical paths in which the metal layer 45 was formed, by the approach used at the process of the above (11), and the same approach, and the electrolytic copper plating film 33 with a thickness of 20 micrometers was further formed in the plating-resist 23 agenesis section by the approach used at the process of the above (12), and the same approach (refer to drawing 10 (b)).
[0278] (18) next, the approach used at the process of the above (13) and the same approach — exfoliation of plating resist 23, and clearance of the thin film conductor layer under plating resist 23 — carrying out — a conductor — the circuit 25 (the Bahia hall 27 is included) was formed. (Refer to drawing 10 (c)) .
[0279] (19) Next, after being filled up with the resin constituent containing an epoxy resin and making it dry using a squeegee in the breakthrough 46 for optical paths in which the metal layer 45 was formed, flattening of the surface was carried out by buffing. Furthermore, hardening processing was performed and the resin layer 42 for optical paths was formed (refer to drawing 11 (a)). furthermore, the approach used at the process of the above (2) and the same approach — oxidation reduction processing — carrying out — a conductor — the front face of a circuit 25 was made into the roughening side (not shown).
[0280] (20) Next, made it dissolve so that it may become 60% of the weight of concentration to diethylene-glycol wood ether (DMDG). The oligomer (molecular weight: 4000) 46.67 weight section of the photosensitive grant which acrylic-ized 50% of epoxy groups of a cresol novolak mold epoxy resin (Nippon Kayaku Co., Ltd. make), 80% of the weight of the bisphenol A mold epoxy resin (oil-ized shell company make —) dissolved in the methyl ethyl ketone trade name: — the Epicoat 1001 15.0 weight section and an imidazole curing agent (Shikoku — formation

— shrine make —) trade name: — 2 organic-functions acrylic monomer (the Nippon Kayaku Co., Ltd. make —) which are the 2E4 MZ-CN1.6 weight section and a photosensitive monomer trade name: — the R604 4.5 weight section — the same — a multiple-valued acrylic monomer (the Kyoei Kagaku K.K. make —) trade name: — the DPE6A1.5 weight section and a dispersed system defoaming agent (the Sannopuko make —) Stir the S-65 0.71 weight section for a container, mix, and a mixed constituent is prepared. The solder resist constituent which adjusted viscosity to 2.0 Pa-s at 25 degrees C was obtained by adding the benzophenone (Kanto chemistry company make) 2.0 weight section and the Michler's-ketone (Kanto chemistry company make) 0.2 weight section as a photosensitizer as a photopolymerization initiator to this mixed constituent. In addition, in the case of 60min-1 (rpm), in the case of rotor No.4 and 6min-1 (rpm), measurement of viscosity was based on rotor No.3 by the Brookfield viscometer (the Tokyo Keiki Co., Ltd. make, DVL-B mold).
[0281] (21) next, the resin insulating layer 22 between layers and a conductor — the above-mentioned solder resist constituent was applied by the thickness of 30 micrometers, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of the substrate in which the circuit 25 (the Bahia hall 27 is included) was formed, the condition for 30 minutes at 70 degrees C, and layer 34' of a solder REJISU constituent was formed in them (refer to drawing 11 (b)).
[0282] (22) Subsequently, the photo mask with a thickness of 5mm with which the pattern of opening for optical paths and opening for solder bump formation (opening for IC chip mounting and opening for optical element mounting) was drawn was stuck to layer 34' of the solder resist constituent by the side of IC chip mounting, it exposed by the ultraviolet rays of 1000 mJ/cm2, the development was carried out with the DMTG solution, and opening was formed. And further, it carries out at 120 degrees C for 1 hour for 1 hour, heat-treats [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, a solder resist layer is stiffened, it has the opening 31 for optical paths, and the opening 35 for solder bump formation, and the solder resist layer 34 the thickness of whose is 20 micrometers was formed. Moreover, the opening 35 for solder bump formation for connecting with a multilayer printed wiring board was formed in the layer of the solder resist constituent of another side by sticking the photo mask with which the pattern of opening for solder bump formation (opening for multilayer printed wiring board connection) was drawn, and performing an exposure development on the above-mentioned exposure development conditions and the same conditions (refer to drawing 12 (a)).
[0283] (23) Next, it was filled up with the resin constituent containing the epoxy resin filled up with the process of the above (19) in opening for optical paths formed at the process of the above (22), and the same resin constituent using the squeegee, and after making it dry, flattening of the surface was carried out by buffing. Furthermore, hardening processing was performed and the resin layer 42 for optical paths was formed. In addition, permeability is 85% and the refractive index of the resin layer for optical paths formed at this process and the process of the above (19) is 1.60.
[0284] (24) Next, the substrate in which the solder resist layer 34 was formed was immersed in the non-electrolyzed nickel-plating liquid of pH=4.5 containing a nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), and a sodium citrate (1.6x10-1 mol/l) for 20 minutes, and the nickel-plating layer with a thickness of 5 micrometers was formed in the opening 35 for solder bump formation, and the opening 31 for optical element mounting. Furthermore, the substrate was immersed in the non-electrolyzed gilding liquid containing a gold cyanide potassium (7.6x10-3 mol/l), an ammonium chloride (1.9x10 to 1 mol/l.), a sodium citrate (1.2x10-1 mol/l), and sodium hypophosphite (1.7x10-1 mol/l) for 7.5 minutes on 80-degree C conditions, the gilding layer with a thickness of 0.03 micrometers was formed on the nickel-plating layer, and it considered as the solder pad 36.
[0285] (25) Next, print soldering paste to the opening 35 for solder bump formation formed in the solder resist layer 34. Furthermore, by carrying out a reflow of a photo detector 38 and the light emitting device 39 to the soldering paste printed to opening for optical element mounting at installation and 200 degrees C, performing alignment of each light sensing portion 38a and light-emitting part 39a While mounting the photo detector 38 and the light emitting device 39 through solder, the solder bump 37 was formed in opening for IC chip mounting, and opening for multilayer printed wiring board mounting, and it considered as the substrate for IC chip mounting (refer to drawing 12 (b)). In addition, as a photo detector 38, what consists of InGaAsP was used as a light emitting device 39 using what consists of InGaAs.
[0286] B. The resin film for the resin insulating layers between layers was produced using the approach used by the production A-1 of the resin film for the resin insulating layers between production B-1. layers of a multilayer printed wiring board, and the same approach.
B-2. The resin constituent for breakthrough restoration was produced using the approach used by the preparation A-2 of the resin constituent for breakthrough restoration, and the same approach.
[0287] B-3. Copper clad laminate which 18-micrometer copper foil 4' laminates to both sides of the insulating

substrate 1 which consists of the glass epoxy resin with a manufacture (1) thickness of 0.6mm or BT resin of a multilayer printed wiring board was used as the start ingredient (refer to drawing 13 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and nonelectrolytic plating processing is performed, and is etched in the shape of a pattern — both sides of a substrate 1 — a conductor — the circuit 4 and the through hole 9 were formed (refer to drawing 13 (b)).

[0288] (2) a through hole 9 and a conductor — the conductor which washes in cold water the substrate in which the circuit 4 was formed, and includes blasting and a through hole 9 for an etching reagent (the product made from MEKKU, MEKKU dirty bond) by the spray after drying — the roughening side (not shown) was formed in the front face of a circuit 4.

[0289] (3) the following approach after preparing the resin filler indicated to the above B-2 — after preparation — less than 24 hours — the conductor of one side of the inside of a through hole 9, and a substrate 1 — the circuit agenesis section and a conductor — the layer of resin filler 10' was formed in the rim section of a circuit 4. That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor — the conductor with which the part equivalent to the circuit agenesis section lays on a substrate the mask which carried out opening, and serves as a crevice using the squeegee — the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 10' was formed by making it dry on 100 degrees C and the conditions for 20 minutes (refer to drawing 13 (c)).

[0290] (4) the belt sander [one side / which finished processing of the above (3) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 — a conductor — it ground so that resin filler 10' might remain neither in the front face of a circuit 4, nor the land front face of a through hole 9, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate. Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 10 was formed.

[0291] thus, a through hole 9 and a conductor — the surface section of the resin filler 10 formed in the circuit agenesis section, and a conductor — the front face of a circuit 4 — flattening — carrying out — the resin filler 10 and a conductor — the insulating substrate which the side face of a circuit 4 stuck firmly through the roughening side, and the internal surface and the resin filler 10 of a through hole 9 stuck firmly through the roughening side was obtained (refer to drawing 13 (d)). this process — the front face of the resin filler layer 10, and a conductor — the front face of a circuit 4 turns into the same flat surface.

[0292] (5) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate — carrying out — subsequently — an etching reagent — both sides of a substrate — a spray — spraying — a conductor — etching the front face of a circuit 4, and the land front face of a through hole 9 — a conductor — the roughening side (not shown) was formed in all the front faces of a circuit 4. In addition, as an etching reagent, the product made from MEKKU and MEKKU dirty bond were used.

[0293] (6) Next, the somewhat larger resin film for the resin insulating layers between layers than the substrate produced by the above B-1 was laid on the substrate, and after carrying out temporary sticking by pressure and judging on pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for sticking-by-pressure time amount 10 seconds, the resin insulating layer 2 between layers was formed by sticking using vacuum laminator equipment by the approach of further the following (refer to drawing 13 (e)). That is, on the substrate, actual sticking by pressure was carried out on the degree of vacuum of 65Pa, pressure 0.4MPa, temperature 80, and the conditions for time amount 60 seconds, and heat curing of the resin film for the resin insulating layers between layers was carried out for 30 minutes at 170 degrees C after that.

[0294] (7) Next, the opening 6 for the Bahia halls with a diameter of 80 micrometers was formed in the resin insulating layer 2 between layers by CO2 gas laser with a wavelength of 10.4 micrometers through the mask with which the breakthrough with a thickness of 1.2mm was formed on the resin insulating layer 2 between layers on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the breakthrough of a mask, and the conditions of one shot (refer to drawing 14 (a)).

[0295] (8) The roughening side (not shown) was formed in the front face containing the internal surface of the opening 6 for the Bahia halls by immersing the substrate in which the opening 6 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing the permanganic acid of 60 g/l, and carrying out dissolution clearance of the epoxy resin particle which exists in the front face of the resin insulating layer 2 between layers.

[0296] (9) Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI). Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out roughening side processing (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 6 for the Bahia halls to be

included) of the resin insulating layer 2 between layers by giving a palladium catalyst (not shown). That is, the above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride ($PdCl_2$) and a stannous chloride ($SnCl_2$), and the catalyst was given by depositing a palladium metal.

[0297] (10) Next, the substrate was immersed into the non-electrolytic copper plating water solution, and the non-electrolytic copper plating film 12 with a thickness of 0.6-3.0 micrometers was formed in the front face (the internal surface of the opening 6 for the Bahia halls is included) of the resin insulating layer 2 between layers (refer to drawing 14 (b)). In addition, the used nonelectrolytic plating water solution and nonelectrolytic plating conditions are the same as that of (10) of the production process of the substrate for IC chip mounting.

[0298] (11) Next, the plating resist 3 with a thickness of 20 micrometers was formed by sticking a commercial photosensitive dry film on the substrate with which the non-electrolytic copper plating film 12 was formed, laying a mask, exposing by 100 mJ/cm2, and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 14 (c)).

[0299] (12) Subsequently, 50-degree C water washed the substrate and it degreased, with 25-degree C water, after washing with the sulfuric acid further after rinsing, electrolysis plating was performed on condition that the following, and the electrolytic copper plating film 13 with a thickness of 20 micrometers was formed in the plating-resist 3 agenesis section (refer to drawing 14 (d)). In addition, the used electrolysis plating liquid and electrolysis plating conditions are the same as that of (12) of the production process of the substrate for IC chip mounting.

[0300] (13) — a conductor with a thickness of 18 micrometers which carries out etching processing of the nonelectrolytic plating film under plating resist 3 with the mixed liquor of a sulfuric acid and a hydrogen peroxide, carries out dissolution clearance and consists of non-electrolytic copper plating film 12 and electrolytic copper plating film 13 further after carrying out exfoliation clearance of the plating resist 3 by NaOH 5% — the circuit 5 (the Bahia hall 7 is included) was formed (refer to drawing 15 (a)).

[0301] A roughening side (not shown) is formed in the front face of a circuit 5. (14) — the still more nearly same etching reagent as the etching reagent used at the process of the above (5) — using — a conductor — subsequently The above (6) It has the opening 6 for the Bahia halls like the process of - (8), and laminating formation of the resin insulating layer 2 between layers by which the roughening side (not shown) was formed in the front face was carried out (refer to drawing 15 (b)). Then, the breakthrough 8 for optical paths which penetrates a substrate 1 and the resin insulating layer 2 between layers was formed using the drill with a diameter of 300 micrometers, and DESUMIA processing was further performed to the wall surface of the breakthrough 8 for optical paths (refer to drawing 15 (c)). In addition, the diameter of the drill used in case the breakthrough for optical paths is formed had desirable 200-400 micrometers, and the drill whose diameter is 300 micrometers was used for it by this example.

[0302] (15) Next, give a catalyst to the wall surface of the breakthrough 8 for optical paths, and the front face of the resin insulating layer 2 between layers by the approach used at the process of the above (9), and the same approach. Furthermore, into the nonelectrolytic plating liquid used at the process of the above (10), and the same non-electrolytic copper plating water solution, the substrate was immersed and the thin film conductor layer (non-electrolytic copper plating film) 12 was formed at the front face (the internal surface of the opening 6 for the Bahia halls is included) of the resin insulating layer 2 between layers, and the wall surface of the breakthrough 8 for optical paths.

[0303] (16) Next, form plating resist 18 in the whole (except for thin film conductor-layer 12 part formed in the wall surface of the breakthrough 8 for optical paths) front face of the resin insulating layer 2 between layers by the approach used at the process of the above (11), and the same approach. A gold cyanide potassium (7.6x10 to 3 mol/l.), an ammonium chloride (1.9x10 to 1 mol/l.), It was immersed in the non-electrolyzed gilding liquid containing a sodium citrate (1.2x10-1 mol/l) and sodium hypophosphite (1.7x10-1 mol/l) for 7.5 minutes on 80-degree C conditions, and the metal layer (gilding layer) 16 was formed in the wall surface of the breakthrough 8 for optical paths (refer to drawing 16 R> 6 (a)). Then, exfoliation clearance of the plating resist 18 was carried out by NaOH 5%.

[0304] (17) Next, plating resist 3 was formed in the part which contains the end-face part of the breakthrough for optical paths in which the metal layer 16 was formed, by the approach used at the process of the above (11), and the same approach, and the electrolytic copper plating film 13 with a thickness of 20 micrometers was further formed in the plating-resist 3 agenesis section by the approach used at the process of the above (12), and the same approach (refer to drawing 16 (b)).

[0305] (18) next, the approach used at the process of the above (13) and the same approach — exfoliation of plating resist 3, and clearance of the thin film conductor layer under plating resist 3 — carrying out — a conductor — the circuit 5 (the Bahia hall 7 is included) was formed. (Refer to drawing 16 (c)).

[0306] (19) Next, after being filled up with the resin constituent containing an epoxy resin and making it dry using

a squeegee in the breakthrough 8 for optical paths in which the metal layer 16 was formed, flattening of the surface was carried out by buffing. Furthermore, hardening processing was performed and the resin layer 20 for optical paths was formed (refer to drawing 17 (a)). furthermore, the approach used at the process of the above (2) and the same approach — oxidation reduction processing — carrying out — a conductor — the front face of a circuit 5 was made into the roughening side (not shown).

[0307] (20) Next, the optical waveguide 18 (18a, 18b) which uses the following approaches for the position of the resin insulating layer 2 between layers and resin layer 20 front face for optical paths, and has the optical-path conversion mirror 19 (19a, 19b) was formed. That is, beforehand, the optical waveguide (micro parts company make : 25 micrometers in width of face of 25 micrometers, thickness) of the shape of a film which consists of PMMA by which the head formed 45-degree optical-path conversion mirror 19 in the end using the diamond saw which is 90 degrees of V types was stuck so that the side face of the other end by the side of optical conversion mirror agenesis and the side face of the resin insulating layer between layers might gather. In addition, attachment of optical waveguide applies to 10 micrometers in thickness the adhesives which become an adhesion side with the resin insulating layer between layers of this optical waveguide from thermosetting resin, and was performed after sticking by pressure by making it harden at 60 degrees C for 1 hour. In addition, in this example, although hardened on the conditions of 60 degrees C / 1 hour, step hardening may be performed depending on the case. It is because it is hard to generate stress by optical waveguide at the time of attachment.

[0308] (21) By next, the same approach as (20) of the production process of the substrate for IC chip mounting a solder resist constituent — adjusting — the resin insulating layer 2 between layers, and a conductor — to both sides of the substrate in which the circuit 5 (the Bahia hall 7 is included) was formed The above-mentioned solder resist constituent was applied by the thickness of 30 micrometers, for 20 minutes was performed at 70 degrees C, desiccation processing was performed the condition for 30 minutes at 70 degrees C, and layer 14' of a solder resist constituent was formed (refer to drawing 17 (b)).

[0309] (22) Subsequently, opening was formed by making one side of a substrate stick the photo mask with a thickness of 5mm with which the pattern of opening for solder bump formation (opening for connecting with a package substrate) and opening for optical paths was drawn to a solder resist layer, exposing on it by the ultraviolet rays of 1000 mJ/cm2, and performing a development to it with a DMTG solution. And further, it carries out at 120 degrees C for 1 hour for 1 hour, heat-treats [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, a solder resist layer is stiffened, it has the opening 11 for optical paths, and the opening 15 for solder bump formation, and the solder resist layer 14 the thickness of whose is 20 micrometers was formed (refer to drawing 18 (a)).

[0310] (23) Next, it was filled up with the resin constituent containing the epoxy resin filled up with the process of the above (19) in opening for optical paths formed at the process of the above (22), and the same resin constituent using the squeegee, and after making it dry, flattening of the surface was carried out by buffing. Furthermore, hardening processing was performed and the resin layer 20 for optical paths was formed. In addition, permeability is 85% and the refractive index of the resin layer for optical paths formed at this process and the process of the above (19) is 1.60.

[0311] (24) Next, like the process of (24) of the production process of the substrate for IC chip mounting, the nickel-plating layer and the gilding layer were formed and it considered as the solder pad.

[0312] (25) Next, soldering paste was printed to the opening 15 for solder bump formation formed in the solder resist layer 14, and by carrying out a reflow at 200 degrees C, the solder bump 17 was formed in the opening 15 for solder bump formation, and it considered as the multilayer printed wiring board (refer to drawing 18 (b)).

[0313] C. IC chip was mounted in the substrate for IC chip mounting manufactured through manufacture **** of the device for IC mounting optical communication, and the process of Above A, the resin seal was performed after that, and IC chip mounting substrate was obtained. Next, by making a position carry out opposite arrangement and carrying out a reflow of this IC chip mounting substrate and the multilayer printed wiring board manufactured through the process of Above B to it at 200 degrees C, the solder bumps of both substrates were connected, the solder connection was formed, and it considered as the device for optical communication (refer to drawing 4). In addition, although the optical path for lightwave signal transmission is constituted by the resin constituent and the opening, and the metal layer of the perimeter, as for the device for optical communication manufactured by this example, the optical path for lightwave signal transmission is constituted from a device for optical communication shown in drawing 4 by the resin constituent and the metal layer of the perimeter.

[0314] It replaces with the gilding layer formed on the non-electrolytic copper plating film at the process of (16) of A of an example 1, and (16) of B. (Example 2) It was immersed in the electrolysis silver plating liquid containing AgCN (5 g/l), KCN (60 g/l), and K2CO3 (15g/(l.)) for 8 minutes on condition that the temperature of 25 degrees C, and current density 1.0 A/dm2, and the metal layer (silver plating layer) was formed in the wall

surface of the breakthrough for optical paths. And the device for optical communication was manufactured like the example 1 except having not formed the resin layer 42 for optical paths at the process of (19) of A of an example 1, and (23), and having not formed the resin layer 20 for optical paths at the process of (19) of B, and (23). In addition, the optical path for lightwave signal transmission will be constituted from the substrate for IC chip mounting and multilayer printed wiring board which were manufactured by this example by an opening and the metal layer of the perimeter.
[0315] It replaces with the gilding layer formed on the non-electrolytic copper plating film at the process of (16) of A of an example 1, and (16) of B. (Example 3) A nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), It was immersed in the non-electrolyzed nickel-plating liquid of pH=4.5 containing a sodium citrate (1.6x10-1 mol/l) for 20 minutes, and the metal layer (nickel-plating layer) was formed in the wall surface of the breakthrough for optical paths. And at the process of (23) of A of an example 1, the process filled up with a resin constituent in opening for optical paths was not performed, but the device for optical communication was manufactured like the example 1 except having not filled up a resin constituent with the process of (23) of B in opening for optical paths. In addition, the optical path for lightwave signal transmission will be constituted from the substrate for IC chip mounting and multilayer printed wiring board which were manufactured by this example by a resin constituent and an opening, and the metal layer of the perimeter (refer to drawing 4).
[0316] (Example 4) It was filled up with the resin constituent for closure between the substrates for IC chip mounting and multilayer printed wiring boards which were connected through the solder connection, and the device for optical communication was manufactured like the example 1 by performing hardening processing after that except having formed the closure resin layer. In addition, the resin constituent containing an epoxy resin was used as a resin constituent for closure. Moreover, permeability was 85% and the refractive index of the formed closure resin layer was 1.60.
[0317] It replaces with the gilding layer formed on the non-electrolytic copper plating film at the process of (16) of A of an example 1. (Example 5) PtCl4and5H2O (4 g/l), NH2HPO4.12H2O (100 g/l), In the electrolysis platinum plating liquid containing 2HPO4 (20 g/l), the temperature of 60 degrees C, (NH4) After manufacturing the substrate for IC chip mounting like an example 1 except having been immersed for 10 minutes on condition that current density 1.0 A/dm2, and having formed the metal layer (platinum plating layer) in the wall surface of the breakthrough for optical paths, The device for optical communication was manufactured like the example 1 except having not performed the process which forms the optical path for lightwave signal transmission at the process of (14) - (19) of B of an example 1, (22), and (23).
[0318] (Example 6) At the process of (23) of A of an example 1, the device for optical communication was manufactured like the example 5 except not having been filled up with a resin constituent in opening for optical paths. In addition, the optical path for lightwave signal transmission will be constituted from a substrate for IC chip mounting manufactured by this example by a resin constituent and an opening, and the metal layer of the perimeter (refer to drawing 1).
[0319] (Example 7) At the process of (14) - (19) of A of an example 1, (22), and (23) The process which forms the optical path for lightwave signal transmission is not performed. At the process of (22) of A of an example 1 By sticking the photo mask with which the pattern of opening for optical element mounting was drawn by the layer of the solder resist constituent by the side of multilayer printed wiring board connection, and performing an exposure development By printing soldering paste to opening for optical element mounting, and carrying out a reflow of a photo detector and the light emitting device at 200 degrees C, after forming opening for optical element mounting The substrate for IC chip mounting was manufactured like A of an example 1 except having mounted the photo detector and the light emitting device through solder. And the device for optical communication was manufactured by performing the process of B and C of an example 1.
[0320] (Example 8) The device for optical communication was manufactured like the example 7 at the process of (19) of B of an example 1, and (23) except not having been filled up with a resin constituent in opening for optical paths. In addition, the optical path for lightwave signal transmission will be constituted from a multilayer printed wiring board manufactured by this example by an opening and the metal layer of the perimeter.
[0321] (Example 9) After performing the process of (24) of A of an example 1, the device for optical communication was manufactured like the example 1 except having used the following approach for the near edge linked to the multilayer printed wiring board of the resin layer for optical paths, and having arranged the micro lens in it. That is, the dispenser was used for the edge of the resin layer for optical paths, the epoxy resin was dropped, and the micro lens was formed by performing hardening processing after that. In addition, the permeability of the micro lens formed here is 92%, and a refractive index is 1.62.
[0322] A metal layer is not formed in the wall surface of the breakthrough for optical paths at the process of (16) of A of an example 1, and the process of (16) of B. (Example 1 of a comparison) After forming the electrolytic copper plating film also in the wall surface of the breakthrough for optical paths at the process of

(17) of A, and the process of (17) of B, On this electrolytic copper plating film, NaOH (10 g/l), NaClO2 (40 g/l), the water solution containing Na3P O4 (6 g/l) — melanism — the melanism made into a bath (oxidation bath) — reduction processing which makes a reduction bath processing and NaOH (10 g/l), and the water solution containing NaBH4 (6 g/l) was performed, and also the device for optical communication was manufactured like the example 1.

[0323] thus, about the obtained device for optical communication of examples 1-9 and the example 1 of a comparison The spectral reflectance of the metal layer which has each gloss, the die length of the optical path for lightwave signal transmission, It is based on design values, such as a path of the cross section of the optical path for lightwave signal transmission, and a luminescence include angle of a light emitting device. As a result of carrying out simulation of the optical path of the lightwave signal at the time of transmitting a lightwave signal from the exposed surface of the multilayer printed wiring board of the optical waveguide which counters a photo detector, in the device for optical communication concerning examples 1-9 In the exposed surface of the multilayer printed wiring board of the optical waveguide which counters a light emitting device, the desired lightwave signal could be received and the device for optical communication manufactured by this examples 1-9 became clear [having the engine performance which can be enough satisfied as a device for optical communication]. In addition, in the example 9, the radius of curvature of a micro lens was also taken into consideration as a design value.

[0324] The result of on the other hand having performed the above-mentioned simulation in the device for optical communication concerning the example 1 of a comparison, Since the scattered reflection of light happens and loss occurs in a lightwave signal, when the lightwave signal which transmits the interior of the optical path for lightwave signal transmission is equivalent to the wall surface of the optical path for lightwave signal transmission, In the exposed surface of the multilayer printed wiring board of the optical waveguide which counters a light emitting device, it became clear that the engine performance as a device for optical communication has the inadequate device for optical communication which may be unable to receive a desired lightwave signal and is applied to the example 1 of a comparison. Furthermore, also when the breakthrough for optical paths was filled up with a resin constituent and also simulation was carried out by the above-mentioned approach about the same device for optical communication as the example 1 of a comparison after forming the breakthrough for optical paths which penetrates the resin insulating layer between a substrate and layers and performing DESUMIA processing to a wall surface, the same result as the device for optical communication concerning the example 1 of a comparison was brought.

[0325] In addition, in the device for optical communication concerning the example 1 of a comparison, when the optical path for lightwave signal transmission was set as die length to which a lightwave signal is not equivalent to the wall surface of the optical path for lightwave signal transmission and a simulation was performed, the desired lightwave signal was able to be received in the exposed surface of the multilayer printed wiring board of the optical waveguide which counters a light emitting device.

[0326] Moreover, when the waveguide loss between the light emitting device mounted in the substrate for IC chip mounting concerning the device for optical communication of examples 1-9, and this light emitting device and the optical waveguide which counters and which was formed in the multilayer printed wiring board was measured by the following approach, that waveguide loss was small and it became clear that a lightwave signal can fully be transmitted. Measurement of the above-mentioned waveguide loss was performed by detecting the lightwave signal which transmitted the lightwave signal whose measurement wavelength is 850nm from the exposed surface, and was transmitted to the photo detector through optical waveguide and the optical path for lightwave signal transmission with a power meter, after a cutter cuts a multilayer printed wiring board so that it may pass along the optical waveguide which counters a photo detector, having exposed the end face of optical waveguide, having minded the optical fiber, minding [installation and] the optical fiber and attaching a power meter.

[0327]

[Effect of the Invention] In the device for optical communication of the first - the third this invention As described above, at least of the substrate for IC chip mounting, and the multilayer printed wiring boards to either The metal layer which the optical path for lightwave signal transmission in which the metal layer which has gloss in a part or all of that wall surface was formed is arranged, and has this gloss Since the lightwave signal which transmits the inside of the above-mentioned optical path for lightwave signal transmission can be reflected suitably, the above-mentioned lightwave signal declines by hitting the wall surface of the optical path for lightwave signal transmission, or is hard to be absorbed. Therefore, according to the device for optical communication of the first - the third this invention, it is hard to generate loss in the lightwave signal which transmits the inside of the optical path for lightwave signal transmission, and the dependability of transmission of a lightwave signal is high and exact optical communication can be realized. Moreover, in the device for optical

communication of this invention, since it has the description which the optical path for lightwave signal transmission mentioned above, even if it is the design in which a lightwave signal is reflected by the above-mentioned optical path for lightwave signal transmission, a lightwave signal can be transmitted suitably.
[0328] Moreover, while a photo detector and a light emitting device are mounted in the position of the substrate for IC chip mounting and optical waveguide is formed in the position of a multilayer printed wiring board in the device for optical communication of the first - the third this invention When the optical path for lightwave signal transmission of a mode of the substrate for IC chip mounting and the multilayer printed wiring boards mentioned above to either at least is formed, the connection loss between the mounted optics is low, and it excels in connection dependability as a device for optical communication.
[0329] By the manufacture approach of the device for optical communication of the fourth - the sixth this invention, since the process which forms the metal layer which has gloss is included in the wall surface of the optical path for lightwave signal transmission, loss does not occur in the lightwave signal which transmits the inside of the optical path for lightwave signal transmission, the dependability of transmission of a lightwave signal is high and the device for optical communication which can realize exact optical communication can be manufactured suitably.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing typically 1 operation gestalt of the device for optical communication of the first this invention.
[Drawing 2] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of the first this invention.
[Drawing 3] It is the sectional view showing typically 1 operation gestalt of the device for optical communication of the second this invention.
[Drawing 4] It is the sectional view showing typically 1 operation gestalt of the device for optical communication of the third this invention.
[Drawing 5] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of the third this invention.
[Drawing 6] It is the sectional view showing typically 1 still more nearly another operation gestalt of the device for optical communication of the third this invention.
[Drawing 7] It is the sectional view showing typically a part of manufacture approach of the device for optical communication of the fourth and sixth this inventions.
[Drawing 8] It is the sectional view showing typically a part of manufacture approach of the device for optical communication of the fourth and sixth this inventions.
[Drawing 9] It is the sectional view showing typically a part of manufacture approach of the device for optical communication of the fourth and sixth this inventions.
[Drawing 10] It is the sectional view showing typically a part of manufacture approach of the device for optical communication of the fourth and sixth this inventions.
[Drawing 11] It is the sectional view showing typically a part of manufacture approach of the device for optical communication of the fourth and sixth this inventions.
[Drawing 12] It is the sectional view showing typically a part of manufacture approach of the device for optical communication of the fourth and sixth this inventions.
[Drawing 13] It is the sectional view showing typically a part of manufacture approach of the device for optical communication of the fifth and sixth this inventions.
[Drawing 14] It is the sectional view showing typically a part of manufacture approach of the device for optical communication of the fifth and sixth this inventions.
[Drawing 15] It is the sectional view showing typically a part of manufacture approach of the device for optical communication of the fifth and sixth this inventions.
[Drawing 16] It is the sectional view showing typically a part of manufacture approach of the device for optical communication of the fifth and sixth this inventions.
[Drawing 17] It is the sectional view showing typically a part of manufacture approach of the device for optical communication of the fifth and sixth this inventions.
[Drawing 18] It is the sectional view showing typically a part of manufacture approach of the device for optical communication of the fifth and sixth this inventions.
[Description of Notations]
100, 200, 300,400,500,600 Multilayer printed wiring board
101, 201, 301, 401, 501, 601 Substrate
102, 202, 302, 402, 502, 602 Resin insulating layer between layers
104, 204, 304, 404, 504, and 604 a conductor — circuit
107, 207, 307, 407, 507, 607 Bahia hall
208, 361, 461, 561, 661 Optical path for lightwave signal transmission
208a, 361a, 461a, 561a, 661a Resin layer for optical paths

208b, 361b, 461b, 561b, 661b Metal layer
109, 209, 309, 409, 509, 609 Through hole
111 211 Openings 114, 214, 314, 414, 514, and 614 for optical paths Solder resist layer
118, 218, 318, 418, 518, 618 Optical waveguide
119, 219, 319, 419, 519, 619 Mirror for optical conversion
120, 220, 320, 420, 520, 620 Substrate for IC chip mounting
121, 221, 321, 421, 521, 621 Substrate
122, 222, 322, 422, 522, 622 Resin insulating layer between layers
124, 224, 324, 424, 524, and 624 a conductor — circuit
127, 227, 327, 427, 527, 627 Bahia hall
129, 229, 329, 429, 529, 629 Through hole
134, 234, 334, 434, 534, 634 Solder resist layer
137, 237, 337, 437, 537, 637 Solder bump
138, 238, 338, 438, 538, 638 Photo detector
139, 239, 339, 439, 539, 639 Light emitting device
140, 240, 340, 440, 540, 640 IC chip
151, 251, 451, 551, 651 Optical path for lightwave signal transmission
151a, 251a, 451a, 551a, 651a Resin layer for optical paths
151b, 251b, 451b, 551b, 651b Metal layer
150, 250, 350, 450, 550, 650 Device for optical communication
260 Closure Resin Layer

[Translation done.]